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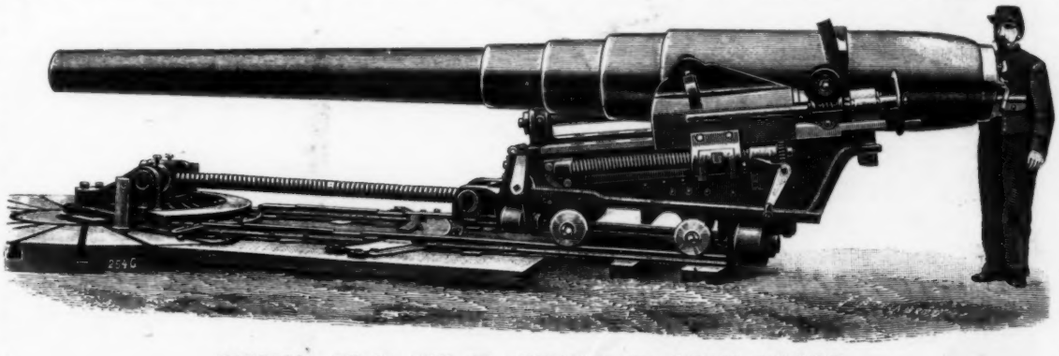
THE SPANISH BATTLESHIP "PELAYO."

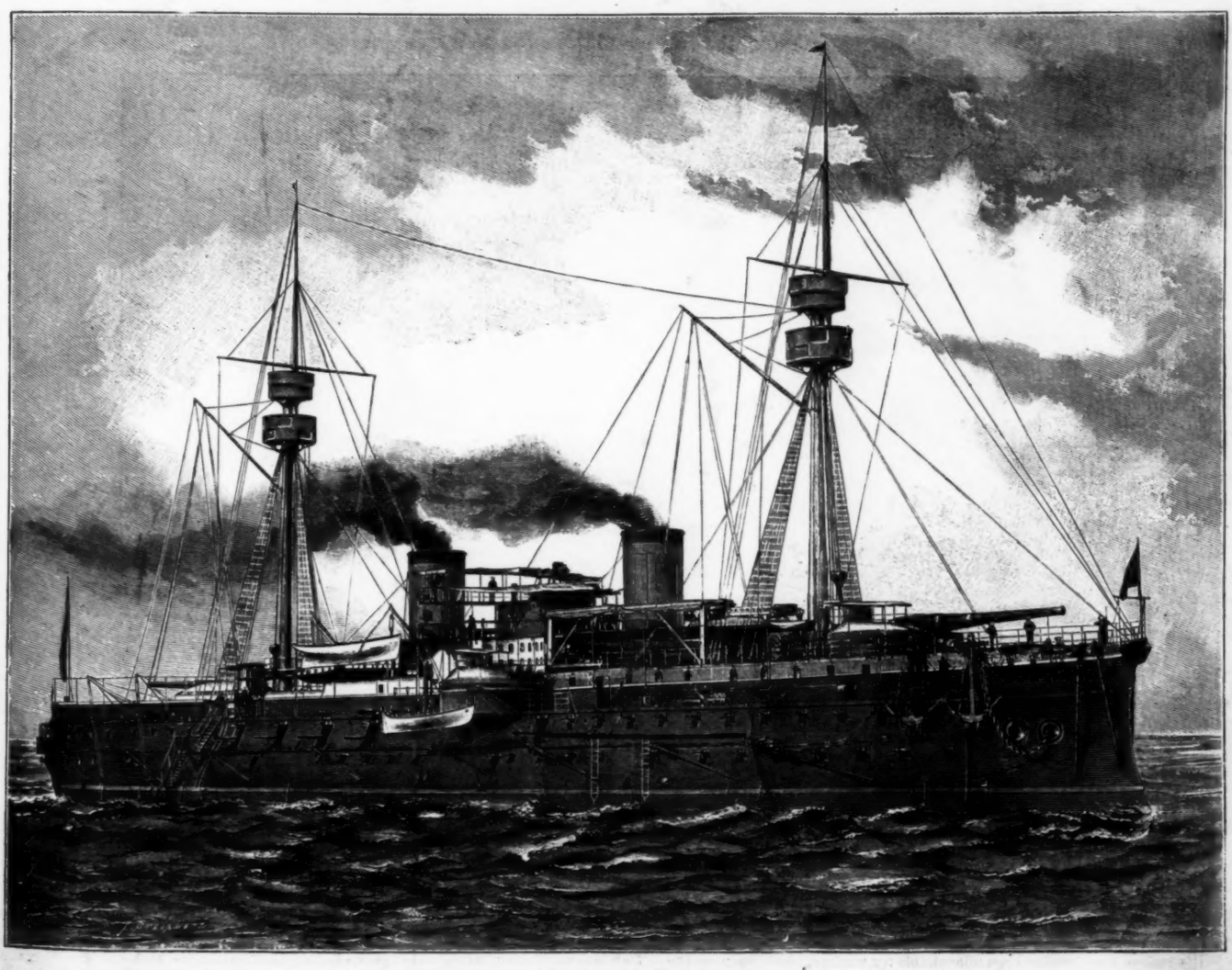
THE recent destruction off Santiago de Cuba of Admiral Cervera's fleet, brings the second Spanish squadron, that lay so long at Cadiz, but is now hovering in an uncertain way about the Suez Canal, into especial prominence. Judging from the reports afforded by the European press, it seems highly probable that Admiral Camara will forego his voyage to the Philippines—if it was ever seriously contemplated—and return home to protect the Canaries or the coast of Spain from the ravages of an American fleet supposed to be mobilizing to this expressed end. The question that now agitates foreign naval circles is, the fitness of Camara's command to cope with any fleet that may be sent eastward by the United States.

Details regarding Camara's squadron are exceedingly meager, beyond the facts that the ships composing it, for the most part, have been "undergoing repairs," and that finally they have, with formal ceremonies, set sail for the East. The fleet includes, with transports and colliers, several torpedo boat destroyers, the one battleship of the Spanish navy, the "Pelayo," and the "Carlos V.," a fast armored cruiser.

The "Pelayo," as the most formidable vessel of the Spanish navy, has long attracted the attention of the public here. Launched ten years ago by the Forges et Chantiers Company, from their yard near La Seyne, near Toulon, France, built under the direct supervision of M. Langan, the engineer-in-chief of the company, engined by M. Orsel, of the Mepenti Works, and the material entering into her construction submitted to the same rigid tests as those demanded by the French navy, it may readily be imagined the ship was most formidable. But how far the "Pelayo" retains her original efficiency is a matter of speculation and conjecture, taking into consideration certain essential facts: 1. The rapid advances and improvements in armor and armament during the past decade: 2. That after a brief service in commission she was laid up in ordinary until the declaration of hostilities, and then required to be "generally overhauled," coupled with the ineradicable habit of procrastination inherent in the inhabitants of the Iberian Peninsula, and that especially obtains in Spanish governmental affairs, whereby every act is relegated to a mañana ("to-morrow") that seldom comes: 3. Those familiar with the methods in vogue at Spanish dockyards, while admitting the "Pe-



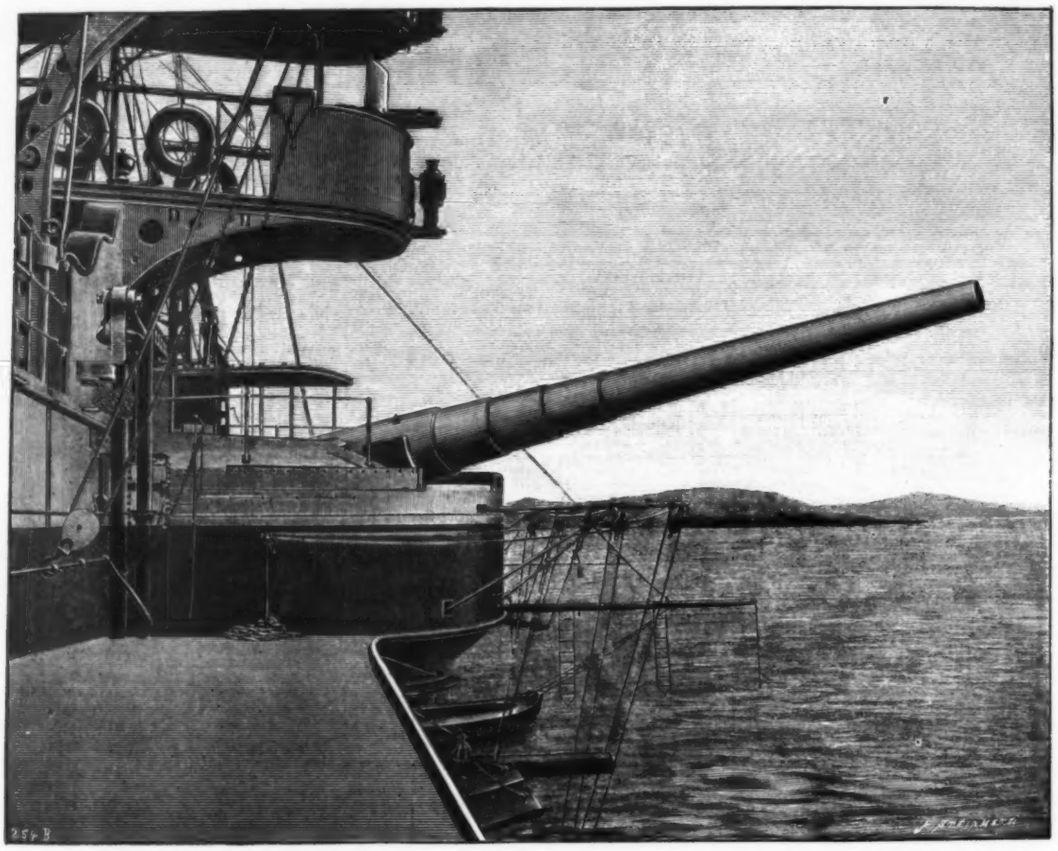
HONTORIA CHASE GUN OF "PELAYO."—6·29 INCHES CALIBER.



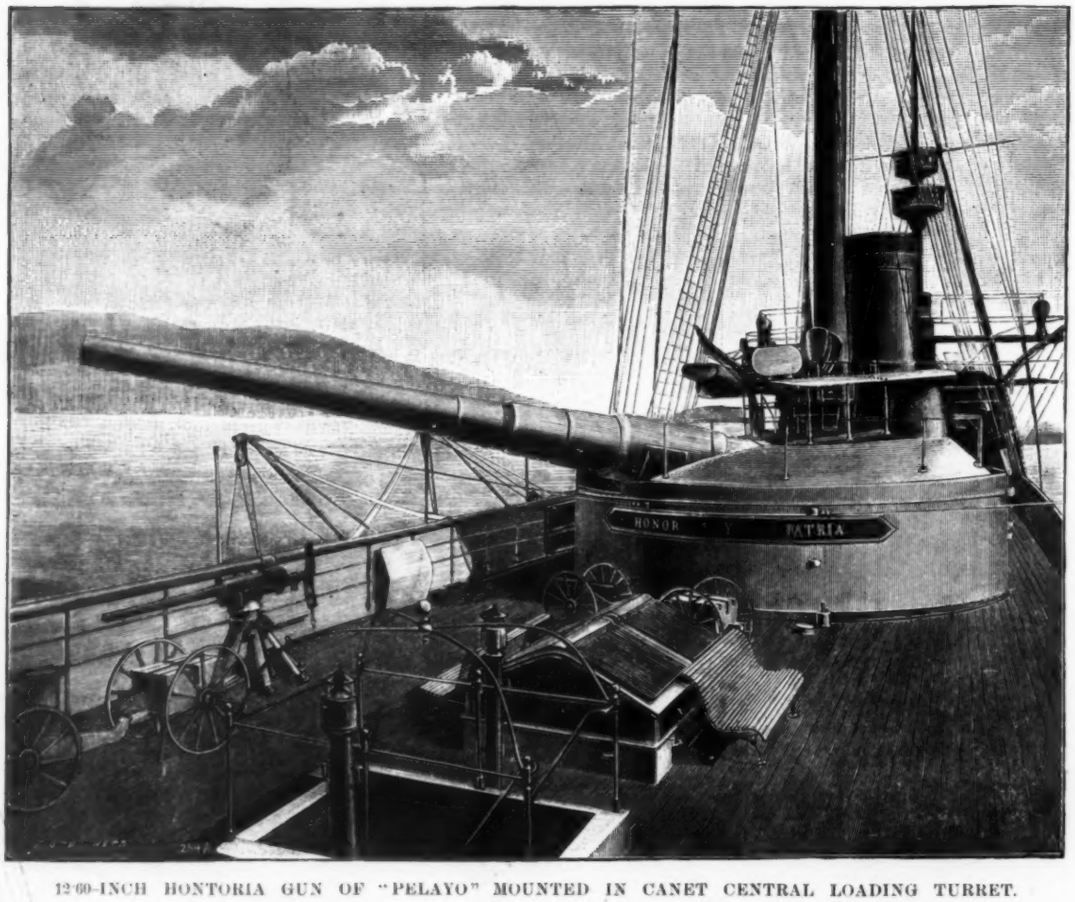
THE SPANISH BATTLESHIP "PELAYO."

layo" would be dangerous if representative of almost any other European power, significantly observe that a battleship is like a fine watch—a valuable and serviceable piece of mechanism when properly conserved and cared for, but one that quickly and fatally deteriorates when neglected: 4. If the United States found it necessary in a measure to rebuild the "Chicago," practically of the same age as the "Pelayo," so that the former has thus far been unavailable for warfare, what must be the condition of the latter?

This great battleship is 346·46 feet length including the spur that constitutes the ram, with an extreme breadth of beam of 66 feet, and an extreme draught of 24·77 feet, and displacement of 9,900 tons; the moderate draught was insisted upon in order to permit of passing through the Suez Canal. From end to end of hull, from just below the waterline to a height of 82 inches, extends a belt of steel armor, 11·81 inches thick at the ends, increased to 17·7 amidships where vital parts demand extra protection; and this is supplemented with-in the hull by coal bunkers of a capacity of 800 tons, arranged on either side of the stokeholds. At the upper edge of the armor belt, and flush therewith, is a steel deck, the openings therein protected by steel castings 39 inches high and 11·8 inches thick. Sixteen transverse watertight bulkheads divide the hull into compartments, which are further subdivided by a longitudinal bulkhead extending from stem to stern post, creating duplicate engine, boiler, ammunition, and store rooms—in all 145 compartments, supposed to con-



11·02-INCH GUN OF "PELAYO" IN CANET TURRET.



12·60-INCH HONTORIA GUN OF "PELAYO" MOUNTED IN CANET CENTRAL LOADING TURRET.

fer a maximum of safety against the effects of torpedoes, and to render their destructive effects chiefly local. A double bottom also extends the full length of the ship, being formed by an inner skin of steel bolted to the frames, forming nearly 100 water-tight cells. All the compartments and cells may be emptied by means of a collecting channel 12 inches in diameter, and its feeders, and connected therewith are two powerful rotary pumps, each with a capacity of 500 tons per hour. There are also other pumps that can be employed temporarily, or as auxiliaries if required.

On the steel deck ample quarters are provided for junior, engineer, and petty officers, and for a crew of 600 men. On the deck above are the quarters and cabins for senior officers, including commandant and admiral, and also the hospital bay.

Two sets of compound condensing engines drive the twin screws, being arranged to work coupled or independently as required, which, under forced draught, have driven the ship as high as 16·20 knots (18·675 miles) an hour; their indicated horse power under natural draught is 9,000. At normal draught a full supply of coal is sufficient, at 12-knot speed, to carry the ship from 4,500 to 5,000 miles, or 7,500 miles at 10-knot speed. There are also a number of small engines designed for special purposes, such as propelling fans, working auxiliary pumps and supplying water to boilers, driving dynamos for the electric plant, besides steam capstans and numerous steam winches; but the most important, perhaps, is a servo-motor placed under the commanding officer in his shelter within the conning turret and connected with a larger servo-motor that controls the steering gear.

Twelve return-flue boilers are arranged in batteries of three each, in four separate compartments, and are supposed to afford a uniform working pressure of not less than 83 pounds to the square inch. Each stokehold is ventilated by a large fan, which can also be utilized for purposes of forced draught.

The armament consists of 17 Hontoria guns, besides quick-firing and machine guns on the upper deck and in the tops. Two Hontorias, in barbette turrets of the Canet system, are mounted, respectively, fore and aft—these of a caliber of 12·60 inches; two others, of 11·02 inches caliber, on Canet carriages, are amidships, one on each side; twelve more, 4·72 inches caliber, with like mountings, constitute the starboard and port broadside batteries; also there is a bow gun of like type, 6·29 inches caliber, the range of which, however, is restricted to the longitudinal axis of the ship.—The general form of these guns is shown in the illustrations. There are likewise seven torpedo tubes placed on the deck immediately above the steel deck; also, the ram is of steel, of moderate proportions, but framed with the vessel and a continuation, as it were, of the armor belt. The stern overhangs sufficiently to afford material protection to the rudder post.

The guns are wholly of steel, the inner tube being reinforced near the breech by a jacket of the same metal, and by a single row of rings, on one of which are the trunnions in the case of the 6·29 and 4·72 caliber guns, the trunnions for the larger caliber being replaced by lugs or projections that support the piece in its cradle; in the latter also, the breech blocks, closed by an interrupted screw, though locked and unlocked by means of rack and pinion, are required to be removed and replaced by hand, thereby considerably interfering with rapid use. The plastic obturator is of the De Bange type with tin disks and bronze rings; and the charge is fired by means of an obturating percussion fuse. The larger guns were made at the Spanish government arsenal

Fig. 1.

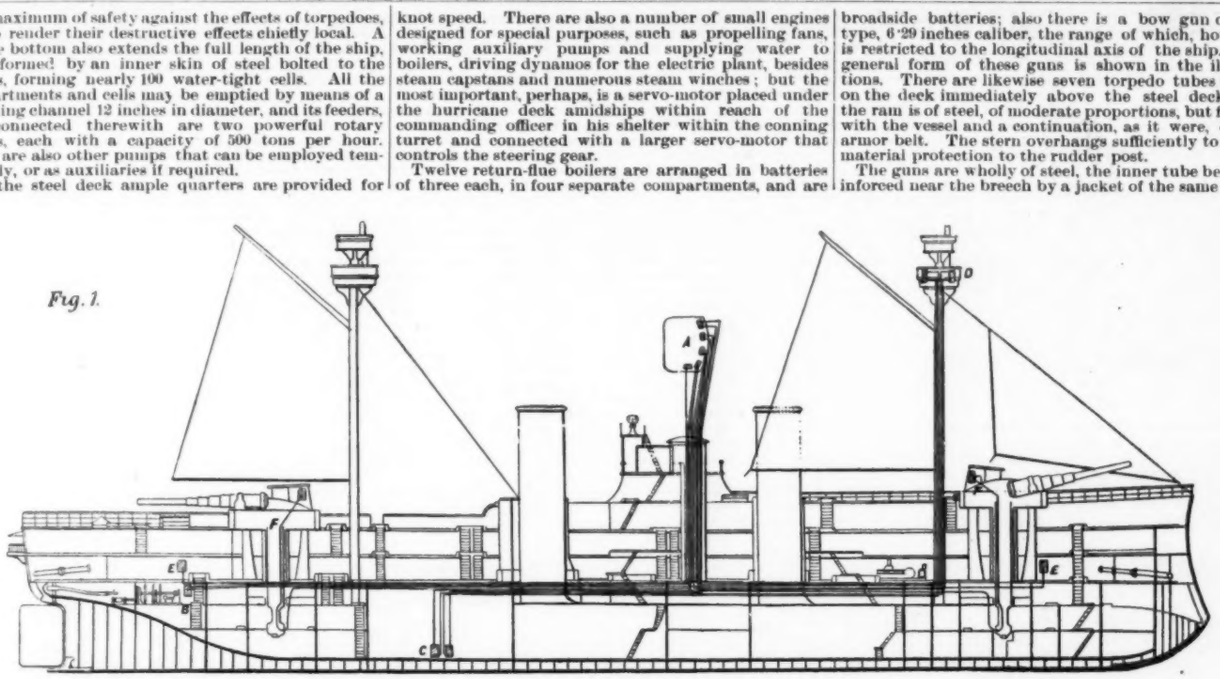


Fig 2.

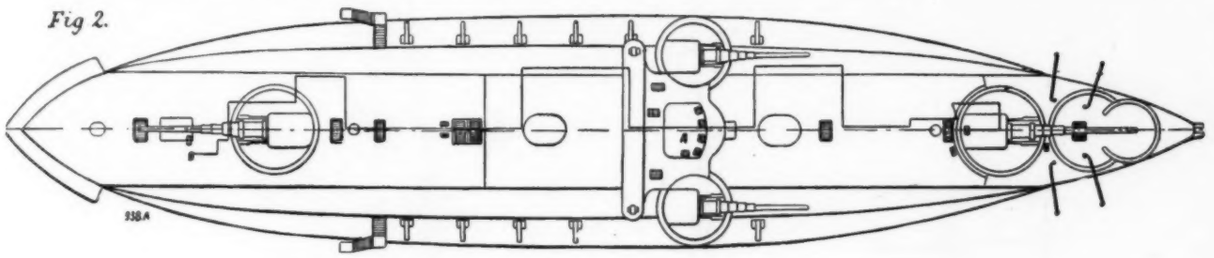
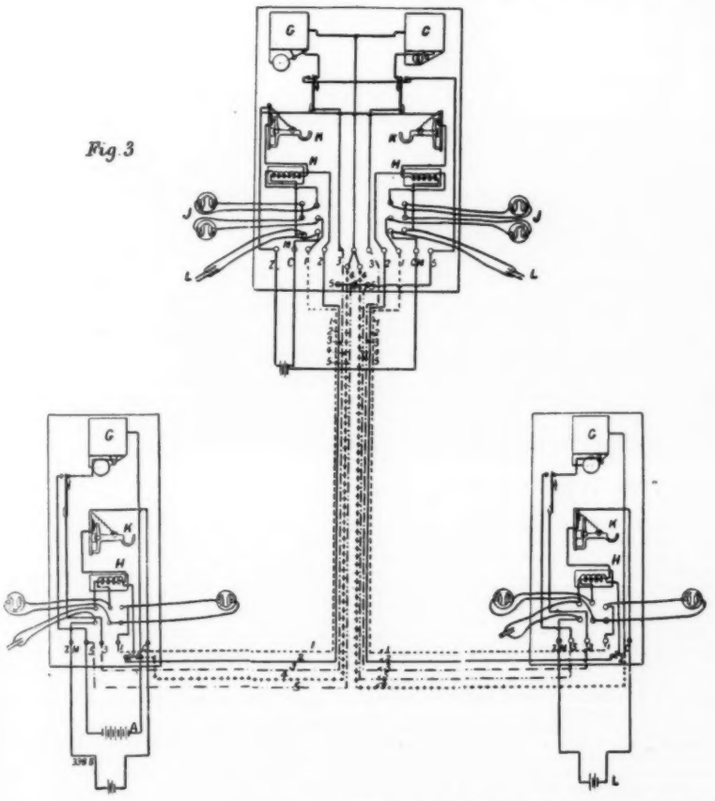


Fig 3



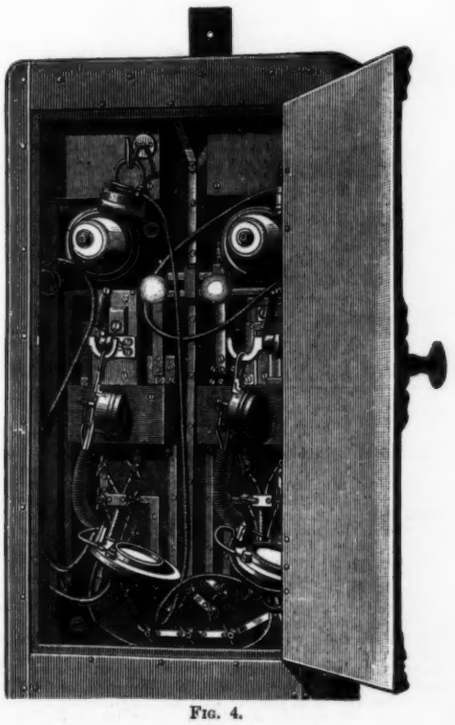


FIG. 4.

TELEPHONIC INSTALLATION ON THE "PELAYO."

at Trubia, the smaller at the Carraca arsenal. The carriages for the chase gun and the broadside batteries are of the Vavasseur-Canet system, with a forward pivot, and, of course, made in France; they are of bronze and cast steel, and comprise the three usual parts, viz., the carriage proper, the under frame, and the base plate. During recoil the carriage runs back up the inclined sides of the under frame, and then returns by itself into the firing position, the amount of recoil being regulated by hydraulic brakes.

The mountings for the 6·29-inch or bow gun also include a special arrangement (see illustration). The carriage is mounted on four wheels which run on rails placed at a level sufficiently above the curved racing path, so that when the gun is run back the racers are clear and the whole weight rests on the rails. On the other hand, when the gun is run forward, the carrying wheels fall into the recesses cut in the rails, and the whole weight is carried on the three racing wheels, the curved paths of which are seen in the cut referred to. The carriage is forward pivoted and connected with the pivot by means of a heavy screw, on which it can be traversed to and fro. The advantage afforded by this arrangement is that, except when in service, the gun can be run back until it is within the ship, allowing the port hole to be closed, affording complete protection.

The mounting of each of the four heavier guns in the barbette turrets is practically the same as obtains to the lesser calibers; it comprises a steel cradle resting on the sides of the under frame which pivots on an axis placed near the wall of the turret and carried on two girders. To the cradle and under frame are attached the cylinders, piston, and other mechanism for checking the recoil and bringing the gun back into firing position.

The mounting and gun are carried on a heavy steel turntable, supported in its turn by a ring of rollers that rest on a circular rail path secured to the deck; and in the middle of this table is the loading tube that passes downward through the central pivot into the ammunition compartment. This permits the gun to be charged in any position. A hydraulic cylinder attached to the turntable raises or depresses the gun for vertical training, and the plunger is connected to the under side of the gun and acts directly upon it; the hydraulic mechanism for horizontal training is placed beneath the deck and actuates a pitched chain passed around a ring on the central loading tube. The ammunition hoists are of the ordinary Canet pattern of a decade ago, and hydraulic loading gear is, of course, employed. The various levers controlling the different hydraulic mechanisms are grouped together on the platform within reach of the officer in charge of the gun, and there is a special safety apparatus whereby it is rendered impossible for any of the numerous maneuvers to interrupt another, when, by accident or error, an attempt is made to execute two operations simultaneously; for example, the ammunition hoist cannot be raised till the proper moment for loading—that is, not until the gun, its breech-block, and the loading ram, are all in their respective and proper relations to this act. The pumps for all the hydraulic gear are situated beneath the steel deck, and thus protected by it and the external belt of armor; and for each turret is required a horizontal three-cylinder engine acting directly on differential double-acting pumps that compress the water to 1,200 pounds per square inch.

The barbette turrets are composed of 15·75 inches of steel plates, and are supported on a framing, also protected by steel 7·87 inches thick, extending down to the steel deck and serving as a protected passage for the ammunition hoists. The forward turret is placed at such a height that the axis of the gun is 31 feet 2 inches above the water line and it is so mounted as to have a firing angle of 250 degrees; on account of the relatively great elevation above the water, this 12·60 inch gun can be fired in almost any kind of a sea. The after gun of same size has a total firing angle of 220 degrees; hence is little inferior in point of traverse range to its fellow forward. The broadside guns can each fire through an angle of 180 degrees, or parallel in each direction with the keel of the vessel; consequently are equally available during chase or in flight. Thus three heavy guns and six of less metal are available either to starboard or port for broadside firing. By an independent brake each turret can be held fast in any desired position. In addition to the fixed armor plates of the turrets, each turret, gun and carriage is protected by a steel roof carried by the platform and turning with it, that is designed to ward off lighter projectiles, or at least receive them at such an angle as to minimize the force of impact; also the shelter intended for those training the gun is provided with a light roof that extends over that of the turret, and to some extent further protects the gun crew.

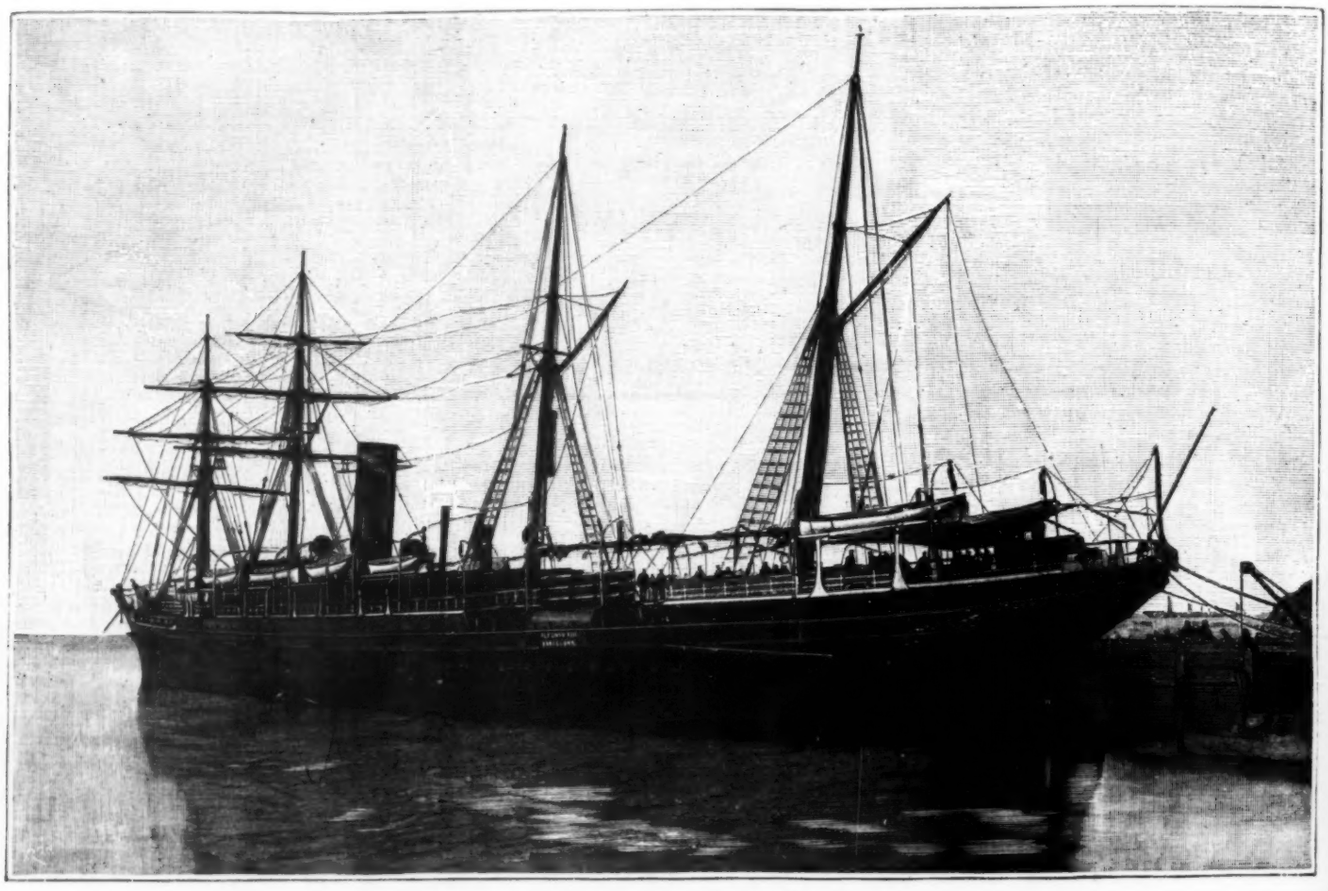
A turretlike shelter on the upper deck constitutes the conning tower, and is very completely fitted up with telegraphic, telephonic, and other transmitting apparatus, as well as with duplicate steering gear, so that the commanding officer can fight his ship under the best conditions and in comparative security. The ammunition stores are arranged in groups, corresponding to the guns to be supplied, and tramways and carriers are provided for their transportation to the different pieces of ordnance. Finally, there are two steel military masts with double tops, the latter fitted with machine guns; but the sail area is limited to less than 6,000 square feet.

From the foregoing it will be observed the ship presents three material weaknesses: First, her broadsides of quick-firing guns are altogether unprotected, and a single shell might put either or both out of action; second, the barbettes are not armored underneath, though the ammunition hoists are individually protected, and consequently a continuous, carefully directed fire might render them hors de combat, if it did not bring them down; third, the mechanical facilities for rapid fire are inadequate.

The telephone system of the "Pelayo" is so complete as to deserve special notice, the more so as it has served as a model for many ships of later construction. It is practically a duplicate of the system since introduced by the Société Générale des Téléphones on the "Amiral Duperre," the "Courbet," and other French naval vessels of this class, whereby communication is maintained with all parts of the ship with greater facility than by speaking tubes. It will be seen that all circuits (Fig. 1) radiate from the conning turret, A, the arrangement being shown diagrammatically to render it more intelligible. From here it is possible to communicate with the wheel, B, the engine room, C, the foretop, D, the torpedoes, E E, and the guns, F F. Every part has been made as strong as possible, and to avoid all chances of a breakdown; to these ends the conductors are of copper ribbon carefully varnished and efficiently insulated, and to avoid contacts as far as possible, complete and independent circuits are run for the bell and for speaking purposes. In those cases in which an officer or a man has two lines through which he can speak, each line is provided with its own complete apparatus for sending and receiving, and no attempt is made to make one apparatus serve for both; by this arrangement all liability to mistake is prevented, and if one instrument should be damaged, the other may still remain intact and useful. This principle is sometimes adopted even in the conning tower, but ordinarily there are so many lines emanating from this point that it is more convenient to use a switchboard. The telephonic apparatus (Figs. 3 and 4) includes a "Berthon" microphone and an "Ader" receiver connected by a handle; a second "Ader" receiver (Fig. 4) is used where the surrounding noise would interfere with properly hearing with one ear. But experiments prove that with this apparatus a conversation is not interrupted between the conning tower and the central battery, even during the firing of the heavy guns. The "Berthon" microphone is so constructed that damp has no influence upon it; this is also the case with the "Ader" receiver, the coils of which are let into a bituminous block. On board the "Devastation," a British battleship, a similar apparatus is, or was, in use that had been immersed in a pail of sea water.

We are indebted for our cuts and many of the particulars to Engineering.

NOTE.—During its refit, changes were made in the motive power and in the secondary battery of the "Pelayo;" but, as no reliable information has been given out, it is impossible to state just what the changes amount to. It is said that she is now provided with Niclausse boilers and a broadside battery of nine rapid-fire guns. It was the intention to place armor on this battery; but, as far as we can learn, the ship was rushed into commission before the armor could be put in place. The ship's speed has not been materially improved, and remains at about 16 knots.



THE SPANISH TRANSPORT "ALFONSO XIII."

THE TRANSPORT "ALFONSO XIII."

ON hearing that the fine ocean steamer "Alfonso XIII.," with troops and large quantities of ammunition on board, had touched at the Barbadoes to take on water, Admiral Sampson detached two vessels of his squadron to capture her.

Great was the anxiety in Spain as to the whereabouts of the "Alfonso XIII.," and greater the joy felt in Spain when the Minister of War, on May 5, received a dispatch from the Captain-General of Puerto Rico, giving news of the arrival of the troop ship.

According to authoritative accounts, the "Alfonso XIII." has succeeded in avoiding the two American cruisers which pursued and tried to capture her.

We present herewith an illustration of the transport. She was built in 1888 by William Denny & Brother, of Dumbarton, Scotland. Her length is 410·55 feet; her beam 47·39 feet, and the depth of her hold 32·44 feet. Her total tonnage is 5,124·80, and net tonnage 3,585·18. The hull is of steel and is provided with a double cellular bottom. Amidships are located the

dining saloon and music saloon. In the stern are accomodations for the officers and crew. There are also 176 large berths and staterooms of the first class and 56 of the second class. Further forward are cabins for 30 men and 12 women, constituting a third class. In the lower deck are accommodations for more than 900 passengers. Of the staterooms, 28 are furnished as special cabins for families. The decoration of these cabins is most beautiful.

The engines are of the triple expansion type, with three cylinders, the pistons working at a pressure of 170 pounds, steam being supplied by three tubular boilers; provision for forced draught has also been made and two Gwynne centrifugal pumps supply the water of the condensers. Powerful Wein pumps keep the boilers supplied. The hydraulic pumping machinery is of the Brown type.

The ship is illuminated throughout by electricity (in all 432 incandescent and arc lights being used). The dynamos and engines, besides providing light, also drive six Brown ventilating fans, which draw out the foul air from all parts of the ship at the rate of 200,000 cubic feet per hour. There are distributed on the vessel 8 lifeboats, a steam launch, 4 ordinary boats and 6 Chambers insubmergible lifeboats. The vessel has provision for 8 Hontoria guns of 14 centimeters and two of 9 centimeters, with the necessary carriages, should the Spanish government desire to use the "Alfonso XIII." as a cruiser.

In the decoration of the saloons, wealth and elegance rival each other.

The ship is fitted with four masts and resembles a yacht in appearance.—La Ilustración Española y Americana.

THE LOSS OF THE FRENCH STEAMER "BOURGOGNE."

WE publish a view of the "Bourgogne," the ill-fated vessel belonging to the Compagnie Générale Transatlantique, and which, with her sister ship, the "Gascogne," has been in continuous service since 1886 until she was sunk near Sable Island, in the North Atlantic, on July 4, with a loss of 574 persons. Both these ships were built by the Forges et Chantiers de la Mediterranée at their La Seyne Works, to the order of the Transatlantic Company, who supplied the Forges et Chantiers with the general conditions to be fulfilled, the detailed plans having been prepared by the Forges et Chantiers' chief engineers, MM. Orsel and Langan. The principal particulars of these ships are as follows:

Length between perpendiculars	492 feet
Beam	52 feet 2 inches
Mean draught, loaded	24 feet
Displacement	9,925 tons
Gross tonnage	7,972 "
Net tonnage	5,000 "
Indicated horse power	9,800

The ships have four decks, with forecastle and poop decks, and the central part of the quarter deck is inclosed by roofs forming promenade decks, which are connected by light gangways. The compartments in the double bottom can receive about 750 tons of water as ballast. The engines are compound condensing, and consist of three similar groups, each with an independent high and low pressure cylinder, the former being above the latter. The shaft is of steel, the crankshaft being on the built-up system and 22·60 inches in diameter; the propeller has a steel boss with bronze blades. The following are some of the principal dimensions of the engines:

Diameter of high pressure cylinders	38·65 inches
" low " "	78·86 "
Length of stroke	69·93 "
Number of revolutions	52 to 62

Steam is supplied from twelve boilers, having a total heating surface of 24,918 square feet; the working pressure is 85 pounds per square inch.

It was stipulated that the acceptance of the "Bourgogne" and "Gascogne" must depend on obtaining a minimum speed of 17·5 knots and 8,000 indicated horse power, and that the consumption of coal per horse power per hour, on a developed power of about 6,100 horse power, should not exceed 1·98 pounds. During the trials, the consumption, with a developed power of 6,100 horse power, was only 1·826 pounds, and with 7,200 horse power it fell to 1·694 pounds, and a speed of 19·035 knots was made with 9,800 horse power. The contract conditions were therefore largely exceeded, and since the ships have been in service many passages have been made averaging 18·50 knots per hour. It should be mentioned that both the "Gascogne" and the "Bourgogne" were intended to serve as transports, or even as cruisers, should the occasion arise, and for this purpose the ships are constructed so as to mount seven guns of 5·51 inch caliber. As will be seen from the engraving, the ships have four masts, two of which carry square sails; they are luxuriously fitted, and have earned a high reputation for regularity and comfort; the accommodation on each boat includes space for 221 first class passengers, 72 second class, and 906 steerage.

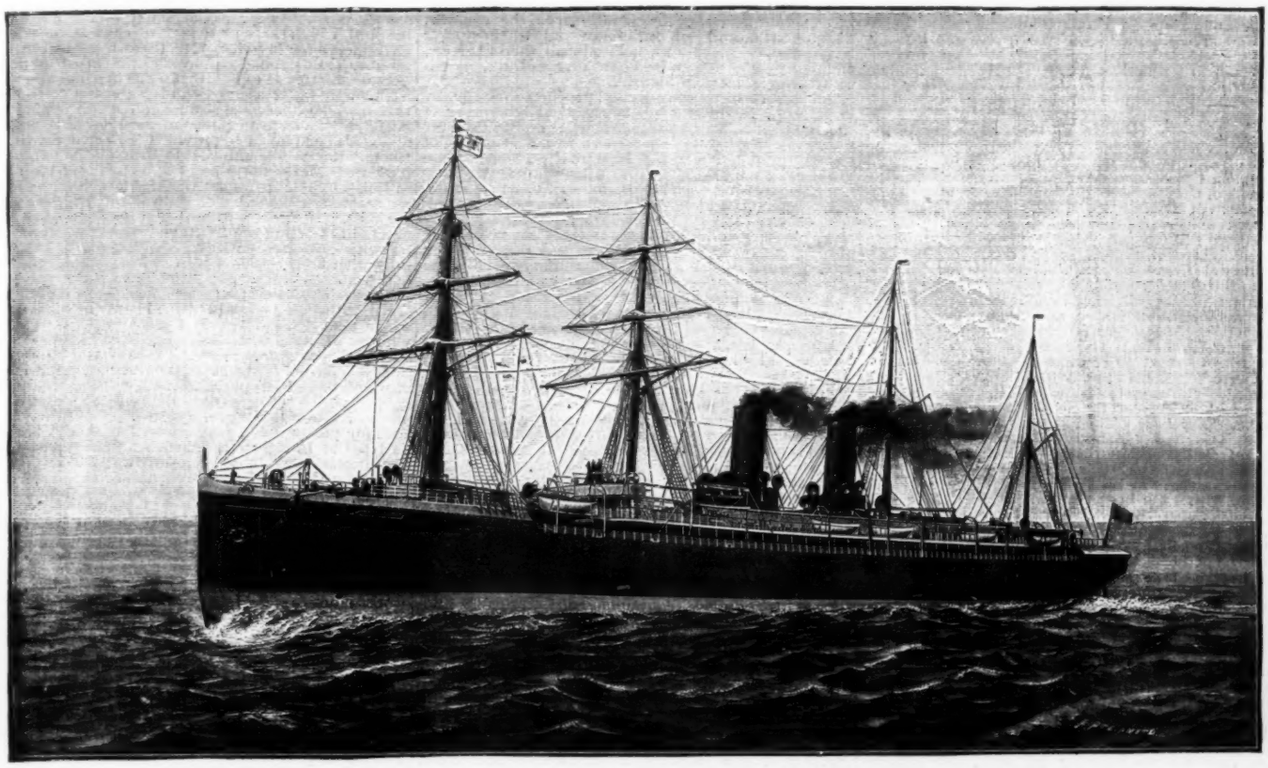
The "Bourgogne" left New York on her regular trip to Havre on July 2, and was sunk at 5 o'clock on Monday, July 4, after a collision with the British ship "Cromartyshire," in a dense fog about sixty miles south of Sable Island. The ship had 750 persons on board, 11 officers, a crew of 222 men, and 517 passengers, 220 being in the first and second cabins and 297 in the steerage. Eleven second cabin, 51 steerage passengers, and 104 of the crew were saved, making a total of 166. All of the officers but four, all of the first cabin passengers, and all but one of more than 100 women on board were lost.

The "Cromartyshire's" bow was stove in, and she was towed by the Allan line steamer "Grecian" to Halifax, with the survivors. The "Bourgogne" sank ten minutes after the accident. She was struck amidships, tearing a great rent in her side. She careened, and in a few minutes went down sideways.

The vessels of this line are commanded by daring captains, who do not follow the lane, but sail on great circles, thus crossing the lanes twice on every voyage. This terrible tragedy of the sea should teach captains a lesson—a few hours less time in making a voyage is of no consequence in face of such an appalling loss of life. The most painful part of the awful catastrophe is yet to be told. The passengers and crew were panic stricken and rushed to the deck when the crash occurred. Boats were manned at once, but they were quickly filled with the crew and the steerage passengers; some of the boats were crushed, others were overturned, and the scene was horrible beyond parallel. Many of the crew and the steerage passengers had knives and they fought like demons, killing men and women right and left.

The steamship created a whirling vortex as she sank, and the passengers who had been able to keep themselves afloat by means of life preservers were sucked down into the whirlpool and drowned. When the suction ceased, about 200 bodies came to the surface. Details of the accident have been given such prominence in the daily press that it is unnecessary to repeat them here. Captain Deloncle went down with the ship, standing on the forward bridge, which redeems to some extent the disgrace of those who should have looked first to the people whom they were engaged to protect.

For our engraving we are indebted to Engineering.



THE FRENCH ATLANTIC PASSENGER STEAMER "LA BOURGOGNE," SUNK JULY 4, 1898.

COLORS USED IN THE MANUFACTURE OF SOAP.

THE colors from which the soapmaker may select are exceedingly numerous, for not only are most of the aniline colors adapted for this purpose, but also a very great number of mineral colors. Until a comparatively recent time the latter were probably exclusively employed, but the advance in the tar color industry in later years has brought about a not inconsiderable change in this respect. A very prominent advantage of the mineral colors is their stability, i. e., not being changed or in any way affected on the exposure to light. This advantage, however, is offset in many cases by the wonderfully beautiful effect of numerous aniline colors, and by the more difficult method of application in the case of the former. The specific gravity of mineral colors being rather high in most cases, they will naturally tend to settle toward the bottom, necessitating crutching of the soap until it is too thick to drop the color. For mottled soap, however, cinnabar (vermilion) and ultramarine are still largely employed.

For transparent soap, of course, mineral colors are not applicable, as they would detract from their transparency; for milled soap, on the other hand, they are very well adapted, as also for cold-made soaps, which require crutching anyway until a sufficient consistency is obtained to keep the coloring material suspended.

A notable disadvantage in the use of aniline colors, besides their sensitiveness to the action of light, is the fact that a majority of them is affected and partly destroyed by the action of alkali. A few of them are proof against a small excess of lye, and these may be used with good effect. Certain firms have made a specialty of manufacturing colors answering the peculiar requirements of soap and being very easy of application, as they are simply dissolved in boiling water and the solution stirred into the soap. To some colors a little weak lye is added; others are mixed with a little oil before they are added to the soap.

For a soluble red color there were formerly used alkanet and cochineal; at present they have been displaced to a great extent, on account of their high cost, by "fuchsin," which is very cheap and of remarkable beauty. A very small amount of it suffices for an intense color, nor is a large proportion desirable, as the soap would then stain. Very delicate tints are also produced by the phthalein colors, of which those named rosbengal, rhodamin and eosin are most commonly used. These colors, when dissolved, have a green fluorescence which heightens their fine effect.

There are also a number of the azo dyes which are suitable for soaps, and these, as well as the phthalein colors, are principally used for transparent soaps. For opaque soaps both aniline and mineral reds are used, among the latter being cinnabar, chrome red and iron oxide. Chrome red is a basic chromate of lead, which is now much used in the place of vermilion, but as it becomes black on exposure to an atmosphere containing even traces only of sulphureted hydrogen, it is not especially adapted for soap. Cinnabar gives a bright color, but it is high in price. Iron oxide, known in the trade as coleothar, caput mortuum, etc., is only used for cheap soaps.

For yellow there are also a considerable number of colors. Among the natural colors these are prominent:

saffron, orlean curcuma (turmeric) and caramel (sugar color); the first named of these is now hardly used, owing to its high cost. Of the yellow aniline colors, special mention is due to picric acid (trinitrophenol), martius yellow, naphthol yellow, the yellow azo dyes and auramin. If it is an orange that is wanted, a trace of fuchsin (red) may be added to the yellow colors named. The use of some unbleached palm oil with the stock answers a similar purpose, but the color fades on exposure. A mineral yellow is chrome yellow (chromate of lead), which has the same advantages and disadvantages as chrome red.—Pharmaceutical Era.

THE MILITARY MEDICAL SERVICES OF CUBA.

THE sanitary services of a field army have always been most difficult to organize. Those who remember the Crimean war will have a painful recollection of these difficulties, but will also realize that great progress in such organization has been accomplished since those days. In Cuba the Spanish forces have had to face obstacles quite as great as those which partially overwhelmed the Allies in the Crimea. Dr. Angel de Larra Cerezo, chief of the clinic at the Cuban hospitals of Madera and Alfonso XIII., has ably explained this situation. Dr. de Larra Cerezo will be known to many English medical men as having presided over the military section of the International Congresses of Hygiene held at London (1891) and at Budapest (1894). He is also a member of the British Sanitary Institute and of many other societies interested in the promotion of sanitary science; his opinion, therefore, on the condition of the military sanitary services in Cuba will be of interest especially at this moment. The plans, diagrams, explanations, and reports presented by Dr. de Larra Cerezo are carefully drawn up, and herewith an attempt is made to summarize the information which was thus placed at the disposal of The Lancet. Even in times of peace it was not an easy matter to provide for the needs of an army which numbered only about 14,000 men, for a great number of the troops were soon invalided by the effects of the climate. Those, on the contrary—and they constituted the majority—who became acclimatized were placed in garrisons where they had but little fatigue to incur. Then suddenly, within the brief period of one year, 200,000 soldiers were sent to Cuba, and within from one to two months of their arrival half these soldiers were invalided. Thus in the course of some twelve months need arose for hospital accommodation for about 100,000 men. Now before the outbreak of the insurrection, that is to say, at the commencement of the year 1895, there were hospitals only in the towns of Havana, Santiago de Cuba, Santa Clara, and Puerto Principe, and nine local regimental infirmaries established in distant places where the difficulties of communication were such that the sick could not be sent to the above mentioned towns. The necessity of creating new hospitals soon became evident, and this work was begun in March and April, 1895. At the commencement of the insurrection the military sanitary corps had throughout the island of Cuba only 2,500 beds at its disposal. On January 1 of the present year there were 45,085 beds ready to receive the sick and wounded. The largest hospitals are first that of Regla, which had 3,600 beds in November, 1896, and now possesses 5,000 beds. Then there are the hospitals of Alfonso XIII. and of Manzanillo, each with 3,000 beds; those of Beneficencia, with 2,100 beds; Santiago de Cuba and Sancti Spiritus, with 2,000 beds each; Ciego de Avila, with 1,700 beds; Cienfuegos and Sagua la Grande, with 1,450 beds; Remedios, with 1,400; Holguin, with 1,300; Madera, with 1,100; and Pinar del Rio, Matanzas, Santa Clara, Casild-Trinidad, Isabela de Sagua, Puerto Principe and Bayamo, each with 1,000 beds. The other hospitals have less than 1,000 beds.

During the last ten months of the year 1895, the whole of the ensuing year, and during the first three months of the year 1897, nearly half a million patients have been treated in these hospitals. The precise numbers were—from March to December, 1895, 49,485; from January to December, 1896, 232,714; and from January to June, 1897, 201,247. The number of deaths was 3,200 in 1895. In 1896 there were 10,610 deaths, and 3,691 during the first quarter of 1897, making a total of 17,501. During the three periods mentioned, of the patients admitted, 35,250 were suffering from yellow fever, and of this number 11,347 died. These figures relate only to the military hospitals. Many more patients were treated in the civil hospitals, in camps, in towns and villages where there are no hospitals, in forts, in private houses, and sometimes in sugar refineries. Statistics have also been drawn up extending over eighteen years giving the number of soldiers who have been treated in the hospitals and infirmaries for yellow fever. The proportion of deaths varies considerably and is sometimes highest when there were but few cases. Thus in 1880 there were 1470 cases of yellow fever with a mortality equal to 37·85 per cent. In 1883 there were 1,235 cases and a mortality of 45·34 per cent. and in 1885 only 120 cases, with a mortality of 55 per cent. The next year, however, the mortality fell to 28·92 per cent. and yet there were only 130 cases. Indeed, since that date the proportionate mortality has never reached 40 per cent. The highest on record is that of 1895, with 7,085 cases, of which 39·46 per cent. died. The previous year there had been only 859 cases (mortality 32·82 per cent.) The following year (1896), in spite of the tremendous strain on the hospital services, the mortality fell to 30·99 per cent., and this out of no less than 23,580 cases of yellow fever. During the first five months of 1897 there was a still greater improvement, for out of 4,636 cases only 27·20 per cent. died. As might well be expected, yellow fever and other diseases have proved far more fatal than the bullets of the insurgents. The number of wounded nursed in the hospitals amounted to 11,902—1,989 in 1895, 7,270 in 1896, and 2,643 in 1897. From March, 1895, when the insurrection began, to May, 1897, there died in the hospitals, from the effect of wounds and from all diseases, 22,497 soldiers.

What with the stress occasioned by the war and the enormous number of patients presenting themselves at the hospitals, it has not been possible to keep very precise statistics as to the number of cases treated for malarial fever, dysentery, typhoid fever, tuberculosis, etc. It is known, however, that in the years 1896 and 1897 there were 79,552 cases of malarial fever of sufficiently severe a character to compel the sufferers to enter the hospitals. Many thousand other cases occurred among the troops who were too far away to be conveyed to a hospital. There is also a record showing that in the second quarter of 1896 there were 3,193 cases of dysentery, of which 351 proved fatal, and 2,903 cases of typhoid fever, resulting in 576 deaths, treated in the hospitals. In the first quarter of 1897 the cases of dysentery amounted to 4,200, with 461 deaths, and of typhoid fever to 1,374, resulting in 210 deaths. From July to December, 1896, and from January to June, 1897, there were 2,381 cases of tuberculosis, followed by 299 deaths. These figures, though incomplete, give an approximate idea of the extent of the strain placed upon the hospitals and medical services of the island. The expense thus entailed, though estimated at a very low figure, represents for a poor country like Spain a ruinous outlay. Fortunately, a great part of the requirements for the Cuban hospitals were sent from the government pharmaceutical laboratories and military sanitary service of Madrid, and were thus supplied at a much cheaper rate than if they had been bought in the open market. Seventeen ambulance carriages were brought over the Atlantic from Madrid, thirteen being of the Lohner type, which with some slight modifications was adopted for the Spanish army. Cases of surgical instruments were also sent over containing many of the newest and best models. The most serious operations were thus rendered possible and everything was provided for elaborate aseptic precautions. No less than 189,000 complete peckages of dressings for wounds reached Cuba from Madrid; then over and above this supply each battalion brought with it the usual regimental medical supplies. From Spain 600 Pravaz syringes, 500 lancets, 850 forceps of the Fergusson, Péant, and Gollin models, 4,500 sounds and bougies, 800 ordinary syringes, and 500 Davidson irrigators were sent over to Cuba. Then there were 1,850 splints for fractures; 1,410 elastic ferrules; 2,500 bistouries, saws, etc.; a number of portable electric batteries, pulverizers, and amputation cases; all the instruments necessary for operations on the eye, ear, nose, mouth, and for lithotomy and tracheotomy; laryngoscopes, speculums, 1,525 clinical thermometers, and many other objects—all sent over to Cuba by the central government at Madrid.

The exports of pharmaceutical products were equally important. In this the pharmaceutical laboratory of the Spanish military sanitary services realized a great saving for the state. In respect to medicaments, of course quinine holds the first place. No less than 11,887 kilogrammes of various salts were sent out to Cuba, comprising 6,400 kilogrammes of basic sulphate, 312 kilogrammes of bromide, 280 kilogrammes of valerinate, etc. Then there were 6,950 kilogrammes of cinchona bark and 950 kilogrammes of extract. Salts of soda, potash and magnesia were also dispatched in great quantities—i. e., 63,200 kilogrammes of sulphate of soda, 85,100 kilogrammes of hypochlorite of lime, 15,000 kilogrammes of sulphate of magnesia, etc. The salts of bismuth were likewise in great demand; 4,500 kilogrammes of subnitrate, etc. The need of sedatives was equally felt, and 400 kilogrammes of opium, together with 51 kilogrammes of salts of morphia, were forwarded to Cuba. Among the antiseptics may be mentioned 28,900 kilogrammes of carbolic acid, 4,450 kilogrammes of boric acid, 1,400 kilogrammes of chloride of mercury, 500 kilogrammes of calomel, 300 kilogrammes of white precipitate, 200 kilogrammes of chloride of zinc, 2,370 kilogrammes of iodoform, 680 kilogrammes of naphthol and naphthalin, 950 kilogrammes of salol, etc. Among miscellaneous articles there were 6,300 kilogrammes of cod-liver oil, 2,530 kilogrammes of castor oil, 1,730 kilogrammes of camphor, 6,220 kilogrammes of citric acid, and 1,950 kilogrammes of tartaric acid, 1,126 kilogrammes of iodine and iodide of potassium, 800 kilogrammes of Fioraventi's balsam, 700 kilogrammes antipyrin, 120 kilogrammes of caffeine, 1,030 kilogrammes of chloroform, 270 kilogrammes of chloral hydrate, 110 kilogrammes of ergotin, 239 kilogrammes of pepsin and pancreatin, 720 kilogrammes of ipecacuanha, 350 kilogrammes of rhubarb, 910 kilogrammes of sulphuric ether, 235 kilogrammes of collodion, etc. No less than 571 kilogrammes of pills or granules were prepared and sent out. Judging from the weight, this would mean about 25,000,000 granules, each being accurately prepared according to the prescription. Then 66,070 kilogrammes of carbolic absorbing cotton wool and 545,000 meters of sterilized gauze were also prepared for the use of the Cuban hospitals.

Apart from what was sent over from Spain and what was prepared by the military medical services in Cuba, some purchases were made from druggists, etc., established in Cuba. These were not very extensive, as at war prices such objects were far too dear. The value of what was imported into Cuba from Spain for the use of the military hospitals from the commencement of the insurrection to the end of January, 1898, is estimated at 3,059,456 pesetas, and it has been calculated that if the same medicaments, etc., had been bought from the druggists and others of Cuba at the war prices, the cost would have been 8,826,248 pesetas. Thus what is known as the Central Park of the Military Sanitary Service at Madrid, and the state institutions generally, have saved the Spanish nation, in the period mentioned, the sum of 5,766,792 pesetas. In this manner vast supplies were forthcoming at small cost, and the quality and purity of the goods provided are stated to have been very strictly controlled.

The field and railway ambulances are described as having rendered valuable service; but the bad condition of the ground was a great obstacle. There are but few roads, and even roads which have been but recently made are soon overrun and obstructed by the exuberant vegetation of the country. The greatest efforts, therefore, were made to bring the sick and wounded to the railway lines, where the railway ambulance wagons greatly facilitated their conveyance to town hospitals. There were 30 such hospital railway wagons running at Havana, Santiago de Cuba, Matanzas, Santa Clara, Manzanillo, Sagua la Grande, Trinidad, and Cienfuegos. Some fine steamships of the Spanish Transatlantic Company were also converted into hospital ships so as to bring back the wounded and the sick to Spain. These ships generally contained four hospital wards of 96 berths each, with free space or air passage at the head and foot and on one side of every berth. These ships are painted white, so that any lack of cleanliness may be more readily seen and remedied. The furniture, folding tables, basins, etc., are of metal, so as to be more readily cleaned. Apart from the four large wards or cabins, these ships also contain four smaller compartments with in all 78 berths, which are reserved for purposes of isolation or for the more serious cases. The floors are kept as smooth and as free from obstacles as possible, and fans worked by steam or electricity help to assure a good ventilation. A Geneste and Herscher disinfecting stove is placed on each hospital ship and porcelain and asbestos filters are employed for the drinking water. The pharmacy is situated in the middle of the ship, so as to be of easy access, and all that is necessary for operations, post-mortem examinations, etc., is provided. These hospital ships can accommodate some 500 patients.

The military hospital at Havana, named after Alphonso XIII., is one of the best in Cuba. It occupies nearly an entire kilometer of ground and is situated on an elevation rather more than a mile outside the town. It was opened at the end of the year 1895, when Marshal Martinez Campos was Governor-General of Cuba. There are fifty different clinics; these include twelve separate pavilions for infectious diseases, with kitchens, residence for staff, etc., attached and apart from the services of the rest of the hospital. The operating room is also in a separate building and furnished on aseptic principles. There are four wards set aside for officers, one of these wards being reserved for cases of yellow fever and another for the wounded. Then there is a separate building devoted to hydro-therapeutics, and there is a special building for the pharmaceutical department. A disinfecting stove is in constant work and a steam laundry close at hand, which enables the authorities to wash and disinfect all the clothing of the patients when they enter the hospital. Another large building contains a model steam kitchen, where the meals for some 3,000 patients can be prepared and cooked daily. Many more separate buildings are occupied by the resident surgeons, the nursing staff, etc. Finally, there are six pavilions near at hand, but separate from the hospital, which serve as a sort of convalescent home or residence for invalids. All these buildings, which number close upon a hundred, drain into a system of sewers constructed especially for the hospital and there is an ample water supply. This water is pumped into two metallic reservoirs situated on a hill behind the hospital. The steam power is used for this purpose and is also employed to provide the electric lighting of the buildings. Though the statistics of the number of patients in all the hospitals of Cuba have not been kept in full, the cases treated at the Alphonso XIII. hospital are carefully recorded. Thus, in 1896 there were 36,202 patients. The greatest number of patients (4,611) were entered in the month of October. The month of August with 4,576 new patients, November with 3,943, and July with 3,740 patients were, with October, the four worst months of the year. The best months were February, with 1,343 new patients; January, with 1,525; and April, with 1,916 new patients. There were in the course of the year 1,494 deaths and 32,420 patients were discharged as cured, the total number of patients being, as mentioned above, 36,202. The greatest number of deaths occurred in the months of August, October, and November. Of the patients treated, 21,731 were medical cases and 4,154 were surgical cases. There were 2,201 cases of venereal disease, 2,381 wounded in war, 2,201 cases of yellow fever, 1,200 cases of cutaneous disease, and 600 of infectious fevers other than yellow fever. The mortality is subdivided as follows: 710 deaths from yellow fever and 86 deaths from other fevers, 618 deaths among the general medical cases, 72 deaths from wounds and 8 resulting after surgical operations.

Though in 1897 there was a greater number of patients, there was a reduction in the mortality. At the commencement of the year 2,288 cases remained in the hospital. During the year 42,540 entries were made, giving a total of 44,828 patients treated in 1897. The worst months were July, 4,930; August, 4,759; June, 4,755; September, 4,529; and October, 4,239 entries. It was only during the months of February and March that the entries (1,864 and 1,831) were below 2,000. In these same months there was the smallest number of deaths. The greatest number of deaths was in the months of December, November, October, and August respectively. In all, there were only 13 more deaths than during the previous year, though the hospital had received 8,500 more patients, a fact due principally to a diminution of yellow fever. The 44,828 patients are grouped pathologically in the following manner: 34,002 internal diseases, 1,480 cases of yellow fever, 1,347 other infectious diseases, 3,585 surgical cases, 952 wounded, 1,846 skin diseases, 1,074 venereal diseases, and 522 ophthalmic cases. Among these patients 1,056 died from internal diseases, 327 from yellow fever, 68 from other infectious diseases, 37 from wounds, and 17 from surgical and syphilitic affections. Thus it will be seen that though there was a great reduction in the death rate from yellow fever, that of the general medical department had greatly increased. This is attributed to the lowered health of the army resulting from the bad climate and the hardships of the campaign. The deaths due to wounds were also comparatively less; the great evil results from the anæmic condition of the troops, and though these figures relate to but one hospital, still they may be accepted as typical of all the military medical services of the island. The staff of the Alphonso XIII. hospital consisted of 170 persons, including 27 surgeons. Nevertheless, on many occasions, this staff proved insufficient for the work which had to be done, and it was only accomplished by extra zeal and by trespassing on the hours set aside for rest. Altogether, and for the entire medical military services of Cuba from the commencement of the insurrection to the middle of the year 1897, no less than 600 surgeons have been engaged in attending to the sick and wounded. Of these, 50 have died in the accomplishment of their duty, the greater number being victims of yellow fever. Six dispensing chemists have likewise met with the same honorable fate. Twenty-five surgeons were wounded on the field of battle and four were killed. There can be no doubt that the military medical staff showed under the most trying and dangerous circumstances all the courage and heroism which have so often distinguished the Spanish people in general and the medical profession in particular.—The Lancet.

NOTES ON MICROSCOPICAL TECHNIQUE.*

By G. CARL HUBER, M.D.

I HAVE been asked by the editor of The Journal to prepare a series of short articles on microscopical technique, giving methods for hardening tissues, of embedding them in paraffin and celloidin preparatory to cutting sections, for section cutting, for staining sections, and for making and staining blood preparations. I am further instructed to present these methods in such simple form that persons unacquainted with the most modern aspects of microscopical technique may be able to understand and use them without difficulty. The microscope has in the last few years become so essential an adjunct to the physician's equipment, such help in making a diagnosis in many of the cases met by him, that he above all realizes fully the necessity of knowing how to use this instrument properly. There are, however, many physicians who have not had time nor opportunity to acquaint themselves with the methods known to the investigators in the laboratories, who nevertheless feel a want in this direction. To meet this want, at least partially, this series of articles is prepared, and in selecting the methods to be given, I have endeavored to choose such as are easy of manipulation, not expensive and not very time-consuming.

THE HARDENING OF TISSUES FOR MICROSCOPICAL EXAMINATION.

It is hardly necessary to say that it is quite impossible to cut even moderately thin sections of the great majority of the tissues removed at an operation or at a post-mortem examination. An attempt to do so will soon convince one of the difficulties attending such a procedure. To facilitate the cutting of thin sections, to preserve as nearly as possible the relative positions of the various elements of the tissues thus sectioned, and to retain as accurately as can be the structure of these elements, various hardening or fixing fluids have been suggested. The number of such hardening or fixing fluids is now very great; some have a very wide application, others are useful in certain special examinations, others again have a very restricted field of usefulness. They all harden the tissue, and all preserve more or less faithfully the tissue elements in the condition in which they were when placed in the hardening fluid. Of this number I shall mention only three, the three which seemed to me would prove most generally useful in the kind of microscopical work a physician may be called upon to do. Before giving these methods in detail, I wish to give a few general directions which should be borne in mind in hardening tissues by any one of the methods to be mentioned.

A. It is not a good plan to wash the tissues in water before placing them in the hardening fluid, certainly not to place them in the water for the purpose of "soaking out the blood."

B. Do not handle the tissues more than is necessary.

C. Do not harden large pieces if it is desired to make sections of the tissues hardened.

It is always a good rule to have one diameter of the piece of tissue to be hardened not more than one-fourth of an inch in thickness. If it seems desirable to harden larger pieces, to show for instance the relation of a growth to the surrounding tissues, a number of parallel cuts, about one-quarter of an inch apart and passing nearly through the tissue, may be made. The parts may then be separated when placed in the hardening fluid without destroying their relative position. Small pieces are to be used because most of the hardening fluids do not penetrate readily. They harden well the outer portion of a piece of tissue, without hardening, or at least not for a long time, the middle portion.

The three hardening reagents to be mentioned are:

1. Alcohol.
2. Formalin.
3. Zenker's fluid.

1. Alcohol.—As a general hardening fluid, there is perhaps none which is so universally applicable as alcohol. Small pieces, not to exceed one-eighth to one-quarter of an inch in diameter, are to be placed at once into ninety-five per cent. alcohol. The volume of alcohol used ought to be about twenty times as great as the tissue to be hardened. If less is used, it should be renewed at the end of a few hours. It is also advisable to place a small quantity of absorbent cotton in the dish or bottle containing the hardening fluid. The alcohol used for hardening the tissues should be renewed every day for the first three days, and if the pieces are not large, they will be well hardened in four or five days, and may be prepared for further manipulation. (Embedding to be described in the next article of this series.) Or, if this is not possible, they should be transferred to eighty per cent. alcohol, in which they may be stored away for future use.

2. Formalin.—Formalin is a forty per cent. aqueous solution of formaldehyd gas. As a fixing or hardening reagent, it is best in a four per cent. solution, which is prepared by mixing ten parts of formalin with ninety parts of water. This fixative, which has been in general use only a few years, seems destined to have a very wide application. It penetrates tissues very readily and preserves the elements quite well. Pieces not more than one-quarter inch in thickness are well hardened in about twenty-four hours. This hardening fluid should be kept in a well stoppered bottle, as it evaporates quite readily; fifteen to twenty times the volume of the tissue should be used. After hardening, that is, at the end of twenty-four hours, the tissues may be placed in eighty per cent. alcohol, in which they remain until further needed.

3. Zenker's Fluid.—One of the best hardening fluids for general work is the solution known as Zenker's fluid. It has the following composition:

Bichromate of potassium	5 parts
Sulphate of sodium	2 "
Bichloride of mercury	10 "
Distilled water	200 "
Glacial acetic acid	10 "

It is prepared by pulverizing the first three ingredients in a mortar and dissolving them in the water; the solution takes place more readily if the water has been heated. This part of the above solution may be kept on hand without deterioration. To it the proper proportion of the glacial acetic acid is to be added just before the solution is to be used. The pieces of tissue to be hardened should not be over one-quarter of an inch thick; they are well hardened in about twenty-four hours. The tissues thus hardened are now to be washed in flowing water for about twenty-four hours. This is most easily accomplished by placing the bottle containing the tissues under the tap of the sink or wash basin, and allowing a small stream of water to run into it. To prevent the tissues from being washed out of the bottle, I have found it convenient to tie a piece of mosquito netting over the mouth of the bottle. After this thorough washing the tissues are preserved in eighty per cent. alcohol. This hardening fluid, like all others containing bichloride of mercury, has the disadvantage of often leaving a precipitate of mercury in the tissues. This may usually be removed by adding to the alcohol into which the tissues are placed after the washing, a small quantity of the tincture of iodine. This forms with the mercury in the tissues, which usually appears in the form of needle-shaped crystals, a soluble and colorless compound, which is indicated by the fact that the iodine color disappears from the alcohol. If it is desired to remove all the mercury from the tissues, the tincture of iodine should be added from time to time until the iodine is no longer removed from the alcohol, which of course is indicated by the fact that the alcohol does not lose the iodine color, that is, retains the brownish color. The following suggestions may be made as to which of the three hardening reagents to select for any given piece of tissue.

If it is desired to make a bacteriological examination as well as a pathological diagnosis of any given tissue, alcohol should be selected as the hardening fluid.

If it is desired to harden the tissues rapidly and simply to determine the nature of the tissue, formalin will answer very well.

If, on the other hand, it is desired to make out the finer details of the protoplasm and a nuclei of the cellular elements of a given tissue, Zenker's fluid should be used in preference to the other two hardening reagents mentioned.

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* Journal of Applied Microscopy.

THE BOLOMETER.

By Dr. S. P. LANGLEY.

IN The American Journal of Science for March, 1881, there appeared an article descriptive of the actinic balance (since called the bolometer), an instrument which has gained acceptance among physicists as a useful aid in the study of radiant heat. It was, it may be remembered, originally devised by the writer to discriminate the heat in any small portion of the grating spectrum, but it has since found wider applications.

As at first constructed, the strips, representing arms of the Wheatstone bridge, were made of iron from 0·001 to 0·0001 of an inch in thickness. The instrument was, even under these initial conditions, very many times as sensitive as the best thermopile the the writer then possessed, but there does not appear to be any definite statement as to the exact sensitiveness in its early form.

In the article referred to, however, the instrument is represented as giving a deflection of about 40 scale divisions (millimeters) from the lunar heat concentrated by a 13-inch lens, and it was sufficiently accurate to give a probable error of rather less than one per cent. for a single observation on a constant source of heat, so that the accuracy of the bolometer (quite a distinct consideration from its sensitiveness) was even then as great as that of the best photometric process. The galvanometer in use at that time was one of the early Thomson pattern made by Elliott.

The first bolometers were made by the writer's own hands. Subsequently the strips were usually cut out from sheets of thin platinum, and in one or two instances made from flattened wire, the strip of the linear bolometer at that time (about 1883) being usually about 10 millimeters long; anywhere from 0·001 to 0·01 of a millimeter thick, and according to its special purpose, being made from one millimeter to 0·1 millimeter wide.

About 1886 the mounting of the instrument had been improved by the writer, so that the strip appeared like the vertical "wire" of a reticule in the focus of a positive eyepiece. It was also movable in some cases by a micrometer screw, and was, in fact, a micrometer thread controlled in the usual way, but endowed with the special power of feeling the radiations from any object on which it was directed.

In the earliest spectrum work the bolometer developed another important quality, its "precision." This quality is quite independent of the accuracy with which it repeats measures of radiation or any constant source of heat, and concerns the precision of setting, as a micrometer thread. It could, even twelve years ago, be pointed, not only like the thermopile, within a fraction of a degree of the place of the source of radiation, as for instance on a bright line in the spectrum, but within a fraction of a minute of arc.

The instrument of course depends for its general efficiency on the galvanometer with which it is connected. That used in 1886* had several improvements due to the suggestions of Sir William Thomson and Prof. Rowland, and was perhaps, at that time, the most effective instrument of its kind in use for such a purpose, the mirror and needles having been specially constructed at the Allegheny Observatory. The mirrors were platinized by the kindness of Prof. Wright, and were at that time nearly a centimeter in diameter. The needles were hollow magnets made by Mr. Very, of the Allegheny Observatory. For the damping mechanism of the older galvanometer, I had substituted a dragon-fly (Libellula) wing, in which nature offers a model of lightness and rigidity quite inimitable by art. At that time, when making a single vibration in 20 seconds, a deflection of one millimeter division of the scale at one meter distance was given by a current of 0·000,000,0005 ampere, the instrument as described being capable of recording a change of temperature in the bolometer strips of less than 0·00001 of a degree Centigrade. So much less than this could be observed by special precaution, that it might be said that this one one-hundred-thousandth of a degree was not only indicable but measurable by the apparatus, which was employed as described, in the determinations of the relations of n to λ for the rock salt prism, and by which the infra-red spectrum was at that time followed by actual measurement, to a wave-length of rather over five one-thousandths of a millimeter.

Since then the bolometer has been used in various researches, of which some occasional account has been given in this Journal. (See numbers for November, 1888, and August, 1890.) During recent years it has been specially employed in making a bolographic map of the lower spectrum, the publication of which has been greatly delayed by conditions incidental to the relations of the Smithsonian Observatory with the government, but which it is hoped will not be deferred much longer.

Without here entering into an account of the work done by it, I have thought that it might be of interest to give very briefly a statement of the present condition and form of the instrument itself, considered under three aspects:

1. Its precision, or the degree of exactitude with which it can be set on a special point, as, for instance, on a line of the invisible spectrum, recognized by its heat radiation alone.

2. Its accuracy, or its capacity for repeating the same measure of radiation under like conditions.

3. Its sensitiveness, or capacity for detecting minute radiations.

The instrument which I will take as the subject of comparison with the earlier one as described in this Journal (August, 1886) is now in use in a chamber automatically kept at a temperature constant within one-tenth of a degree Centigrade.

The strips, the essential part of the instrument, are in the present case made by Mr. C. G. Abbot, and are of platinum, the central one being rather less than 0·1 of a millimeter wide. (The case is now made of metal instead of ebonite, and is surrounded by a current of water.)

It is quite possible to make bolometer strips much narrower, but this is less necessary with the employment of the long-focus, image-forming mirror, so that in the present case the strip is at such a distance that it subtends an angle of 3·4 seconds. Its angular aperture is in practice adapted to that of the slit, which, with the use of the long collimator employed by the writer, gives a capacity of pointing (pointing, that is, in the dark) with a probable error of little over a second of arc. Quite recently, owing to the use of a novel collimating system of two cylindrical mirrors proposed by Mr. Abbot, the slit, though at a moderate distance, can have an opening sufficient to avoid prejudicial diffraction effects, while subtending an angle of considerably less than one second of arc.

In the galvanometer, the use of the fine quartz threads and specially small mirrors, originally due to Mr. Boys, has lately been carried to what comes near the practicable extreme, the quite invisible thread being made some 30 centimeters long, the mirror 2 millimeters in diameter, and weighing but 2 milligrammes, and its six needles, of proportionate weight and dimensions.

This system is now made to serve with a much shorter swing than that formerly employed. If we reduce it to a time of single vibration of 20 seconds, only for the purpose of comparing it with the values already given in the earlier form, we obtain the results submitted below.

Before giving them, however, it is to be mentioned that the apparatus at Washington is most unfavorably situated, owing to its being subject to tremor from the traffic of neighboring streets and to other causes, which it has been the object of years of struggle to conquer. This has been so far done that the values presently to be given (which, it will be remembered, are only attainable in a chamber of constant temperature, with special precaution against disturbance from external tremor) can be counted on as real values, always obtainable under proper conditions, and, in fact, rather within than without the average working capacity of the instrument.

I here consider the bolometer as at present employed:

(1) With regard to its precision, or exactness of pointing. The old thermopile could be set on a portion of the spectrum only with an error of a considerable fraction of a degree. The linear bolometer as employed in 1886 could be set with a probable error of a fraction of a minute of arc. The bolometer as employed to-day, and moved through the spectrum by clockwork, can be automatically set with a probable error of a single observation of little over a second of arc, can be set, that is, in the dark, with a precision little inferior to the capacity of the eye in setting a micrometer thread in the light.

(2) As to its accuracy. I have had occasion recently to take a series of measures of successive throws of the galvanometer, using as a source of heat an Argand petroleum flame in a common student's lamp. I had no photometer at hand, but taking the usual statements of the text books as to the accuracy of vision, it might be expected that such measures with the eye would give a probable error of about one per cent. (This is where sources of light of similar quality are compared.) The probable error of a single galvanometer reading was between 0·03 and 0·04 of one per cent., and this included the fluctuation of the intensity of the source of radiation, and the error of estimating tenths by the reader on the scale, both quantities of nearly the same order as the error in question. It seems safe to say, then, that no error attributable to inaccuracy of the bolometer could be detected by the means employed.

(3) As to sensitiveness. In the early work, for a time of single swing of 20 seconds, a deflection of one millimeter with the scale at a meter's distance was obtainable with a current of 0·000,000,0005 of an ampere. At present, under such circumstances, a similar deflection would be obtained with 0·000,000,000,0012 ampere, that is to say, the apparatus is about 400 times as sensitive as it was when first described.

At present, the bolometric apparatus under the conditions already cited will indicate a change of temperature in its strips of at any rate much less than one-ten-millionth of one degree Centigrade.

*American Journal of Science, Third series, vol. xxxii., p. 90, 1886.

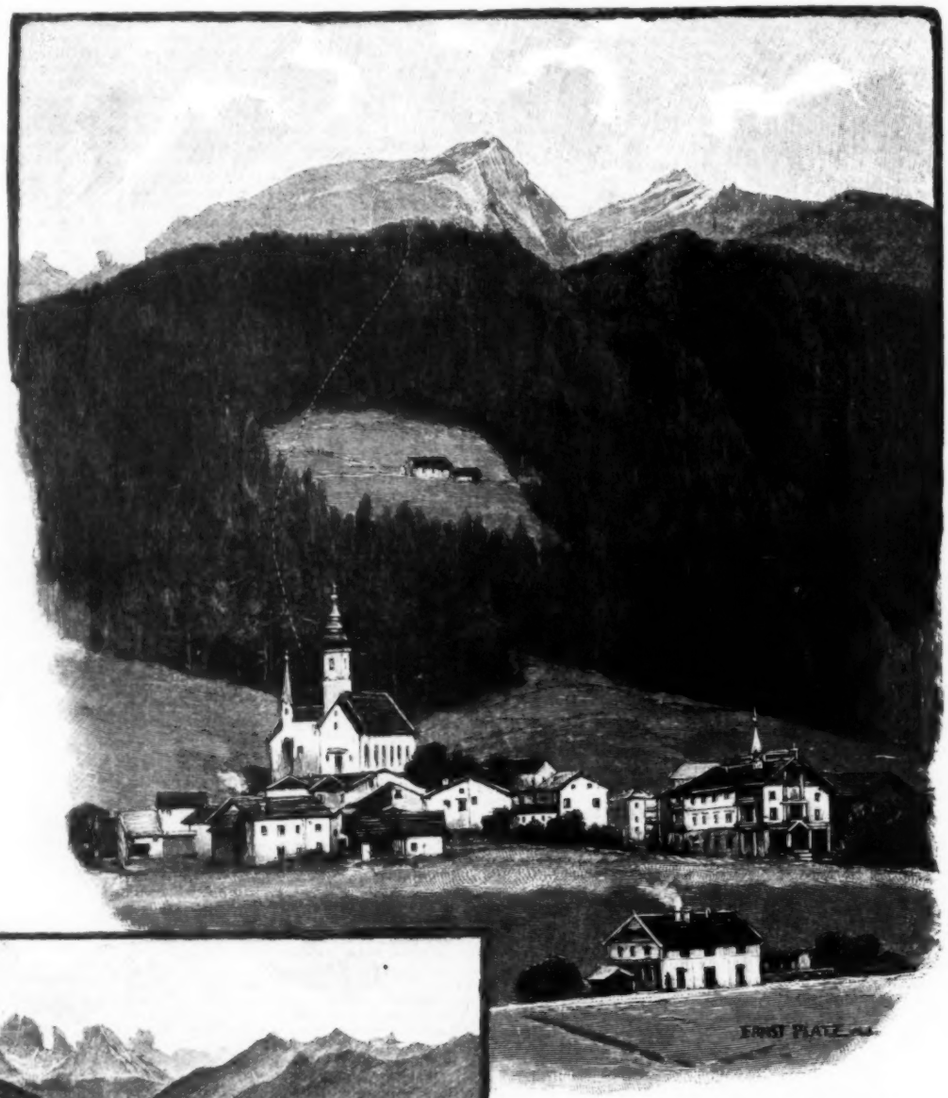
Most spiders have eight eyes, although some species have only six.

A PROPOSED MOUNTAIN RAILROAD FOR THE TYROL.

WE have heard much about the mountain railroads of Switzerland, but heretofore little has been done in this direction in its neighboring state, the Tyrol; now, however, various plans have been considered for presenting new attractions to the traveling world, and among others are plans for an electric railroad from that well known health resort, Gossensass, on Mount Brenner, to the Amthorspitz, which commands a most extensive and beautiful view and has long been known as a peak that well repaid the alpinist for the trouble of climbing it. There are few mountains in the Alps that are so directly on the main line of the railroad, so easily ascended and at the same time offer such remarkably fine views as Amthorspitz, which, being in the heart of the Tyrol, commands a view of the jagged limestone range on the north, the Dolomites on the south, close at hand the glaciers and proud peaks of the Ziller Valley range and beyond the deep Eisak Valley the mighty tops of the snow and ice covered giants of the Stubaier and Otzthaler Alps, while in the far distance can be seen the shimmering snow peaks of the Adamello Alps on the Lombardy border.

Amthorspitz and this wonderful panorama can now be reached from Gossensass by vigorous climbers in about four hours, but if this road is built, it will be made accessible to those who have not the physical strength to undertake such a climb. Engineer Frhr. v. Tröltsch has published a document giving maps and plans of the road and setting forth the advantages of the particular system proposed—a cable driven by electricity. The idea is to construct the road from Gossensass to a point a short distance below the summit, and divide it into three sections, each section being provided with a cable. The real summit of the mountain is not suitable for a railroad terminus nor for a hotel, and consequently it is proposed to place these a short distance below, as already stated. Where the road leaves the woods on the lower mountain slopes and comes out upon the Hühnerspielalm, near the present "Amthorhütte," there will be a hotel (Hotel Hühnerspielalm), which will be built as a resort for invalids in search of invigorating air, and beautiful walks and promenades will be arranged for these guests. The location, which has an elevation of 6,550 feet, is exceptionally fine.

A capital of more than $250,000 will be required for building this road, and the fare for the trip through the valley will probably be about $1 and for that



GOSSENSASS, WITH AMTHORSPITZ.

THE PROJECTED RAILROAD, WITH VIEW OF THE DOLOMITE MOUNTAINS.

up the mountain about $2, which is not a high rate compared with the charges on other mountain roads. The new road will make a delightful excursion of what before was a most toilsome climb that could be undertaken by only the strongest mountaineers, and therefore it will doubtless be well patronized.

We are indebted for the accompanying engravings and the above data to the Illustrirte Zeitung.

In England more than 10,000,000 oil lamps are used nightly. They cause 300 deaths annually, and in London 165 fires in a year have been traced to them.

THE RIGHT TO PROPERTY IN AN IDEA.*

By ALLEN RIPLEY FOOTE, Member of the American Economic Association and of the American Academy of Political and Social Science.

DEFINITIONS.

WEBSTER defines the term "property" in part as follows:

"Property.—(3) The exclusive right of possessing, enjoying, and disposing of a thing; ownership; title. (4) That to which a person has a legal title, whether in his possession or not; thing owned; an estate, whether in lands, goods, or money.

"Literary Property.—Property which consists in written or printed compositions. The exclusive right of publication as recognized and limited by law."

INTRODUCTORY.

The avowed object of all honest anarchists, socialists, reformers of every class of opinion and degree of intelligence; the dreams of all philosophers, poets, and prophets; the teachings of every professor of ethics, morals, and economics; the mission of all governments and of all religion, is to cause men everywhere to understand the principles of justice, to incarnate them in their lives as a controlling motive power and force, inspiring and guiding their thoughts and actions. All efforts of the past, all agitations of to-day, all hopes for the future having as an objective point the betterment of the whole of humanity, morally, socially, and economically, may be rightly interpreted as a demand for justice. Every cause for discontent, every political issue will be permanently and satisfactorily removed or settled when all men recognize that, so far as human agencies in the affairs of men are operative, justice is done. A review of the past, a careful summary of the present aspect of all public questions teaches and emphasizes one fact: The people want justice, but they do not know how to obtain it.

Justice is born of honesty and intelligence. Honesty is the image of God in the hearts of men. Intelligence is a condition of mind. Granting the presence of honesty in the hearts of the people, their lack of knowledge as to how to obtain justice and their failure to secure justice must be ascribed to defective intelligence. Honesty will cause all men to wish to do justice, but the degree of justice which they do will be measured by their own standard, by their conception or understanding of the principles of justice. If the action of any man is unjust, the cause of the injustice must issue either from a deficiency in honesty or a defective intelligence. As all whose opinions are worthy of consideration claim a full measure of honesty, attention need be directed only to their mental development.

Close observation will disclose the fact that in their attempts to obtain justice, those who have directed the thought and energies of the people have centered attention upon efforts to formulate and enforce demands for justice, rather than upon efforts to so educate men as to cause each one to do justice, under any and all conditions, whether his action is directed toward a fellow-man, a family, a municipality, state or nation, or the universal society of humanity. The universal demand for justice can be satisfied by each man doing justice, and in no other way. The problem of how to obtain justice for all men, individually and collectively, will be completely and correctly solved by causing the actions of all men, individually and collectively, to be just. When individual action is just, collective action will be just also. Just collective action is impossible so long as collective society, large or small, is

* A lecture delivered before the Franklin Institute, November 26, 1897, and published in The Journal of the Institute.

composed of men whose conception of the principles of justice is defective. It is the duty of all who study the welfare of humanity from the view-point of the rights and duties of the individual or from the rights and duties of collective society, any grouping of individuals, large or small, to give the problem of how to cause every individual action to be just their most serious attention. This question once solved, all other problems for the moral and economic betterment of the people will become simple and easy of solution or cease to exist.

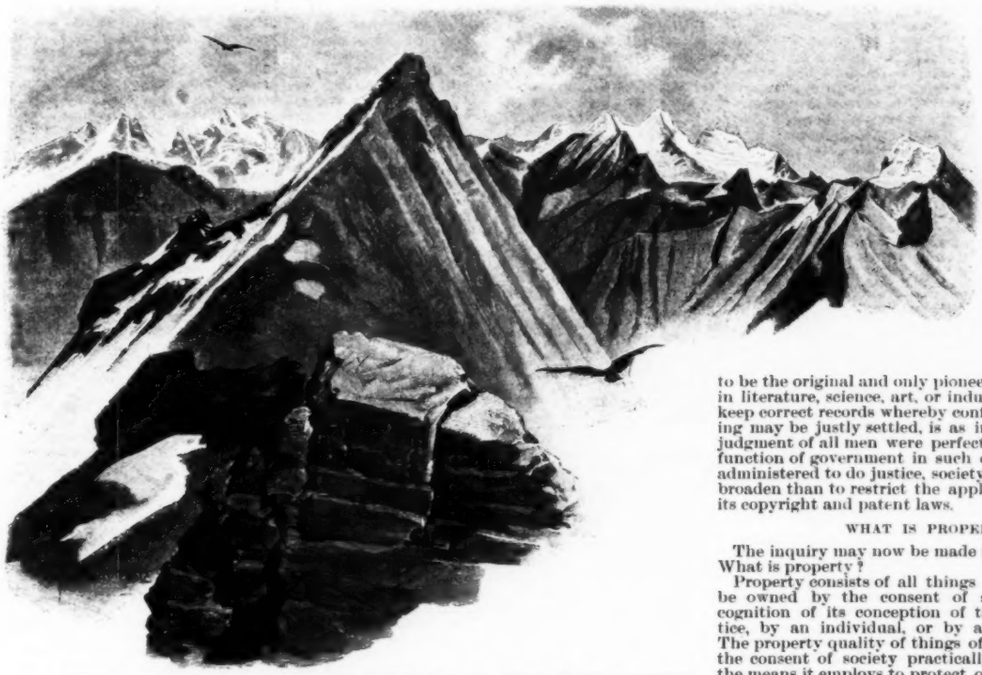
THE RIGHT TO PROPERTY IN AN IDEA.

The best test for the correctness of a person's conception of the principles of justice, or of his honesty, is his willingness to recognize, and, recoguizing, to give compensation for the right to property in an idea. This is true, because ideas, being the most intangible of all products of labor, are the most difficult to protect by the requirements and punishments possible to enacted law. Many persons whose moral sense of right and wrong is sufficiently clear to protect them from any desire to steal anything protected by enacted law feel no restraining influence from their conscience to retard them from taking anything not so protected and appropriating it to their own benefit without tendering compensation to its author, even when they know the author, and know he has need of a just compensation for his labor. The necessity for plainly stated enacted laws, defining what may and what may not be freely taken for the exclusive use or enjoyment of individuals singly or collectively, is created by the inability of many persons clearly to perceive the principles of justice, to understand their requirements, and to govern their actions in accordance therewith. Compensation is due from each individual for every intellectual benefit received, to some person or group of persons working collectively for educational, charitable, religious, mechanical principles; and in the invention of devices for controlling and utilizing the resources and forces of nature. In every department of thought a mind may project itself beyond the boundary of the discovered and broaden the sphere of knowledge by making clear that which had not previously been understood, or bringing to view the hitherto unknown. The right to property in ideas that lead to such results, and to the results obtained by them, is as just as the right to property in the things produced by manual labor employed to mould the idea into a concrete form that can be offered for sale as a new creation. It is the duty of society to do justice by protecting every author, discoverer, and inventor in his right to property in his ideas as well as in the products of his physical labor.

AUTHORS MUST PAY THEIR DEBTS.

While every person should be protected in the ownership of all that is justly his own, no person should be protected in the ownership of more than his own. Every useful idea, discovery, or invention is based upon the work of those who lived before. Every person who now makes a tool or writes a philosophical statement is assisted by the work of those who have passed to a sphere where rights to property are unknown, and also by the labor of his contemporaries. By that order of nature which sets a limit to the life of the body, the results of the work done by those who once lived, and which they once rightfully owned as their property, become the common heritage of all the living. The dead cannot own property.

Improvements, additional adaptations, new ideas, and inventions are suggested to the minds of careful observers. In this manner are induced all improvements in industry; facilities of every kind; comforts of every description; entertainments of every class, and the power more perfectly to utilize the resources and forces of nature. Out of the stock of common knowledge



VIEW FROM AMTHORSPITZ—PANORAMA OF THE ALPS OF THE ZILLER VALLEY.

or industrial economic purposes; or for the proper government of a municipality, State, or nation, or for all of humanity.

Defective moral vision causes those who are benefited by society and government to feel no rebuke of conscience when they neglect their civic duties. The most important function of society or government is the protection of individuals in their just right to life and property. The necessity for such protection is the basis of the right of governments to exact the payment of taxes for their support. This necessity, and the taxation caused by it, will become less and less arduous as enacted laws become more just and are honestly and intelligently obeyed or executed.

An idea unexpressed is in the undisputed possession of him who conceives it, but it has no tangible existence. It cannot be communicated to others without being given a form, more or less tangible, in words or signs voiced or written. When given a tangible existence, by what rule of justice can it become, without compensation, the property of another not its author? In so far as society fails to give to an author the protection necessary to enable him to enforce his right to property in his own ideas, society permits everyone to take and use them freely, without rendering compensation for them. It permits those who will to be legally unjust. In this way the interests of authors are sacrificed for the common good. A law clearly securing to every author the right to property in his ideas will not prevent any author from becoming a public benefactor. He can voluntarily relinquish his right, by deed to the government, and thus enrich all to whom his ideas are of value, and by the same act prevent others from claiming a property right in them.

THE RIGHT TO PROPERTY IN DISCOVERIES AND INVENTIONS.

The right to property justly adheres to the acquisitions of close observations resulting in the discovery of gems, precious metals, useful natural materials and ideas spring. The known suggests that which may be known.

If ideas, discoveries, and inventions are suggested by observation of what others have done, what is due to society from authors, discoverers, inventors; in fact, from all owners of property? If society had failed to protect the laborer in his right to own the results of his labor; if the author, discoverer, or inventor had been denied an opportunity to observe existing things, to draw upon the resources and forces of nature which are the property of no one, but are a part of the common inheritance; or, if they had been debarred from all access to the stock of common knowledge, is it conceivable that the product of labor would have been saved or that the idea, discovery, or invention would have been his?

The principles of justice operate with impartial force upon the conduct of individuals toward society, as upon the conduct of society toward individuals. The requirements of justice, which confirm to each person all that is rightfully his own, require that he shall have no more than his own. More than is rightfully his own no one can have without doing an injustice to another. To do justice every person must give to society full compensation for the benefits he receives from society, not only for its protection of his right to property, but for the assistance he obtains from existing things, from natural resources and forces, and from the stock of common knowledge. The man who causes two blades of grass to grow where one blade grew before, and keeps both blades for himself, together with all knowledge of how he accomplished such a result, is not a benefactor of his race. His benefaction, if any, is in proportion to the division he makes with others of his extraordinary increase, and the extent to which he permits his valuable knowledge to be diffused, without compensation, through the stock of common knowledge, thus making it a free heritage of all.

The reimbursement to society, voluntarily or exacted, for benefits received, intangible or tangible, is a requirement that cannot be determined with exact justice. The human mind is not yet sufficiently endowed with the power of intelligent judgment and honest action to enable it to do complete justice under all conditions. It must be content with doing substantial justice, being guided thereto by the demands of equity.

COPYRIGHT AND PATENT LAWS.

Copyright and patent laws are framed on the principles of equity. They should give equal recognition to the rights of individuals and of society. They should divide an accruing benefit for a brief period between an author and society, and beyond that transfer the entire increment of information to the stock of common knowledge from which all may take freely. The life of an individual is brief. The life of society is continuous. It is good policy to offer a proper inducement for the desired achievement. The highest good of society, of any collective group, as of individuals, requires that it shall develop itself to the best of which it is capable. This is its right and its duty. If, by securing to an author, discoverer, or inventor of a useful idea or thing an opportunity to realize for his own a profit, during a part of his life, no matter how large—profit cannot be out of proportion to usefulness—society can stimulate all minds to do their best, it will not only enrich itself by the activity of the living, it will inherit rich endowments from those who pass beyond the jurisdiction of its enactments.

If there were, however, never a question as to the right to property in an idea, discovery, or invention, there would be a necessity for copyright and patent laws, and for the system of administration founded upon them. On account of the fact that all ideas, discoveries, and inventions are outgrowths of suggestions from the known, it is a common occurrence to have several persons, almost simultaneously, honestly claim to be the original and only pioneer to lead and advance in literature, science, art, or industry. To make and keep correct records whereby conflicting claims so arising may be justly settled, is as important, and, if the judgment of all men were perfect, would be the only function of government in such cases. Founded and administered to do justice, society can better afford to broaden than to restrict the application and scope of its copyright and patent laws.

WHAT IS PROPERTY?

The inquiry may now be made in its broadest sense, What is property?

Property consists of all things of value which may be owned by the consent of society, given in recognition of its conception of the principles of justice, by an individual, or by any collective group. The property quality of things of value is created by the consent of society practically expressed through the means it employs to protect owners in their right to possess, enjoy, and dispose of that which they may legally own. I say consent of society, because there can be no property where there is no social consent or contract to protect anyone's right to possession.

If no one recognizes a thing as having value, no one wants to own it, therefore, no protection is required to make possession of it sure. It is not property. A thing recognized as having value, ownership of which is not confirmed by the consent of society, cannot be exchanged for other things having value, because all are permitted freely to take it, therefore no protection is granted to make possession of it sure. It is not property. Things of value, the ownership of which is not confirmed by the consent of society, are those things upon which no labor has been expended. Justice requires that every laborer shall be unmolested in the possession and enjoyment of the products of his toil. In recognition of this demand, society grants protection for the right to own all things created by labor. This protection constitutes such things property.

THE BASIS OF THE RIGHT TO OWN PROPERTY.

It is now necessary to examine the basis upon which the right to own property rests.

The consent of society to the ownership of things of value is based upon its conception of the principles of justice. This conception of justice is expressed by enacted law. The divine law is the moral and the enacted law is the legal basis to all right to own property. This right is founded on the natural right of a creator to possess the products of his creation, his labor. This is the demand of justice. This right is conceded by all who honestly and intelligently demand or seek to do justice. This is the basis of the title to all property whether owned individually or collectively by two or more persons for their private use and benefit, or by associations, municipalities, states or nations for the common use and benefit of all members, citizens or subjects.

Protection is assured by the operation of moral and physical forces. The most effective protection is given by a correct understanding of and a desire to obey moral law. Moral law teaches honesty as a principle.

Economic law enforces honesty as a practice. Man must understand and willingly obey the principles of moral law before he can understand and correctly apply the principles of economic law. When no person will permit himself to be unjust, there will be no injustice. Barring the factor of knowledge, the absence of which may render one unable to determine to whom a thing of value rightly belongs, the right to property will be completely protected without the presence or the use of enacted law, or of its representative physical forces, when the moral law is correctly understood and universally obeyed.

Once, when walking in Central Park, New York, I chanced to hear a few words exchanged between two young girls who were walking near me:

"Let's pick some flowers," said one.

"Oh! I daren't," answered the other.

"Come on, the policeman won't catch us, he is around the turn in the walk behind the bushes," persisted the first.

"I daren't catch myself stealing," replied the second, as she passed on, admiring but not touching the flowers.

If the high sense of honor, the clear-sighted self-respect of that little girl controlled the actions of every person, stealing would be an unknown vice, the protection of property by physical force would be an unknown burden upon the industrious.

In proportion as self-respect is strong or weak, asserting and maintaining a high standard of honor in individuals and in society, is the right to property respected or disregarded. Regard of the right to property determines the position of an individual in the scale of moral development, from vicious brute to conscientious man. In proportion as regard of the right to property is strong or weak in individuals and in society are men civilized or brutal, and in proportion as men are civilized or brutal do they recognize and respect the sacredness of life and property.

A clear recognition of the right to property is necessary to the protection of life. This is illustrated daily by the acts of men engaged in robbery or the wanton destruction of property. When so engaged they do not hesitate to take life to save themselves from capture. It is conceded that the right to life is valued above all other rights. It is clear that protection of the right to life and property is based on justice, and is made most effectual by a correct understanding of and disposition to apply the principles of justice. The intelligence to recognize these principles, the power to incarnate them and to make them a governing force guiding his every action, raises man above the brute and constitutes him another and a higher order of being. There can be no moral or economic government among brutes.

Whenever a change occurs in the popular conception of the principles of justice, either through a clearer understanding or a misinterpretation of moral law, and by reason of such change society withdraws its consent to the ownership of any class of property, all things so affected cease to be property. Against the destruction of property by such a cause property owners have no defense. When a popular verdict has once declared that the right to own a certain thing or class of things shall cease, owners of such property are powerless to maintain the right to ownership, even though they defend it with their lives. This fact has an epoch-making illustration in the destruction of property in slaves caused by the withdrawal of the consent of society to such ownership, voiced by the emancipation proclamation issued by Abraham Lincoln, President of the United States.

LIMITATIONS ON THE RIGHT TO OWN AND USE PROPERTY.

The natural right of every person to own and use as he pleases the products of his labor, his ideas, discoveries, and inventions can be fully exercised only when he is isolated. In a state of isolation there is no property. As soon as a man associates with another, his natural right to do as he pleases with his own is modified by a due regard for the similar rights of others. By association society is formed. The welfare of society requires that protection to the right to property it grants for individual good shall not be used to the injury of any one or of society. Should it be, it is the duty of society, in defense of its welfare, to withdraw consent and thus destroy the property. The fundamental principles of justice require that all property shall be owned and used with a due regard for the similar rights of others. Rights to the ownership and use of property are not vested rights. They are not absolute. They are qualified by the principles and conditions that give them existence.

The expenses of government incurred in behalf of the protection it affords to the ownership of property must be collected from the property it protects. Government frequ ntly exercises its sovereign power and dispossesses the owner of property, by public sale, to satisfy its claims for taxes, giving title to the buyer. Rights to property that can be thus annulled are not vested rights. They are not absolute. They are created and may be destroyed by the consent of society.

In a final analysis it is clear that the ownership of all property is protected, not by constitutions, enacted laws or decisions of courts, but by the consent of society based on its conception of the principles of justice. Changes in the popular conception of these principles or of their proper application may cause existing constitutions, enacted laws, and court decisions to be out of harmony with the popular belief as to what is just and right. Such a change will cause existing conditions to appear unjust. A people stung to the quick by a sense of injustice, believing themselves to be the victims of unjust laws, an unjust administration of laws, or of an unjust industrial, commercial, or financial system, will not cease to agitate, nor ought they to cease to agitate, until every change is made that is necessary to bring the constitutions and enacted laws upon which court decisions are based into strict accord with their conceptions of the principles of justice.

Such changes are steps of progress in civilization when in the right direction. They are steps of retrogression when in the wrong direction. When they come by the peaceful processes of evolution, the new absorbs and utilizes all of good that can be found in the old with injury to none. When they come by the destructive processes of revolution, the suspicions, prejudices and discontent of the people, having brewed an anger that cannot be controlled, it bursts forth in a wild fury and destroys the old in order to secure an opportunity to create a new government or an industrial system that will accord with their conceptions of justice. It is not in the power of any man or class of men permanently to prevent the oncoming of these changes. Delayed they may be. Directed they can be. No power can stop them absolutely. The life of nature finds expression in change. When changes cease, humanity and all nature will be dead. It is idle to resist a tendency to change. It is the highest wisdom to guide it in a right direction.

These truths should cause everyone to realize that all rights to property, of whatever kind, depend upon the correct moral and economic education of the people. Every property owner should realize that the protection of his right to ownership depends primarily upon a correct conception of the principles of justice by the people, not upon the use of force. When an appeal to force is made sufficiently drastic to arouse all of the people, it will be found that millions who toil wield the balance of power, and that they cannot wield it justly when they are not guided by a correct conception of the principles of justice. A state of inaction cannot be maintained. History is repeating itself. Conditions are rapidly developing such as lead to revolution. Men can remain free only by recognizing the correct principles of justice and properly applying them in every detail of their affairs. Happiness cannot exist without freedom. Freedom cannot live when justice is not done. The time has come when the American people must make progress by means of correct moral and economic education or by revolution.

THE ECONOMIC LAW OF LABOR AND PROPERTY.

The natural law of labor and property is founded on the principles of moral and economic law. Being a natural law, it is universal in its application and binding upon all men. In discussing this subject elsewhere I have said:

"In isolation a man has undisputed possession of the surplus products of his labor. . . . The natural right of the isolated to the undisputed possession of the product of his labor and to be unrestricted in the use or disposition he may make of it cannot be enjoyed by associated men except as it is qualified by a due regard for the similar right of others. This is the foundation of the natural law of labor and property.

. . . . . .

"If, prompted by an ignorant self-interest, one man decides to take more than his just share of the joint product of himself and others, because he is stronger and has the brute power to do so, such a violation of natural moral law removes the transaction from the domain of economic science and carries it back to the domain of moral science. The brute must be taught the moral law, and have intelligence enough to understand it and honor enough to obey it before he can be dealt with as an economic factor."*

The laborer and the capitalist must yield obedience to the requirements of justice, if justice is to be established. Neither can secure a permanent gain by violating the economic law and taking an unjust share of their joint products. Justice cannot permit any person to be a permanent gainer by his own acts of injustice.

THE NATURAL LAW OF JUSTICE.

The natural law of justice is superior to all constitutions, all enacted laws, all court decisions. It is uninfluenced by the opinions or actions of men. It is the only correct ideal. It is the only changeless standard. Rightly understood and obeyed, it will enable all men to realize the highest attainable good. Disregarded, whether through ignorance or through vicious selfishness, it punishes with imperious and merciless exactness every step of divergence from a true course. In no age have the ablest men comprehended all there is of wisdom. In every age the toiling masses have failed to understand and to utilize all the wisdom formulated for their guidance and the betterment of their condition. Slowly and painfully they have been working their way toward the realization of higher and still higher ideals, sometimes helped and many times hindered by their trusted leaders. The entire experience of mankind confirms the correctness of the theory that man is ennobled or degraded by the truth or error contained in his beliefs. Whenever a clearer understanding of the natural law detects an error in a conception of the principles of justice, and the affairs of men are realigned in accordance with the requirements of the new light, civilization and human happiness make a distinct gain. Whenever a conception of the principles of justice is clouded by suspicion, prejudice or vicious selfishness, and the affairs of men are blindly aligned by false standards, civilization receives a disastrous blow. Happiness is stabbed in its heart.

In this aspect of the subject it is a solemn duty to direct attention to the fact that thousands of advocates are ceaselessly working to miseducate the people. They are poisoning the minds of the people with sinister suggestions and prejudices founded on falsehoods, to which they give currency in the guise of facts. They are creating a sense of injustice by magnifying imaginary wrongs. They are preparing the way for a widespread destruction of property through the dissemination of false conceptions of the principles of justice. If their work is not promptly and thoroughly counteracted by correct moral and economic education, a disaster, such as the cause of civilization has not suffered since the dark ages, will come. Political development has reached a point at which choice must be made between doing the work of correctly educating the people or suffering the disaster of a revolution.

This is neither the time nor place to amplify this note of warning. But I beg to assure everyone to whom these words may come that they are written with a full knowledge of their serious import based on facts that admit of no doubting. These facts have been made possible by the activity of the dishonest and of the misinformed; and also by the apathy of those who rely upon enacted law and the use of force to protect them in the possession of that which they call their property. Unless property owners perform their civic duties far more perfectly than they have done in the past, the day will come when this reliance will fail them. Millions of workmen are being taught that the property of the wealthy has been acquired by robbery, and that "When a man is robbed, the way for him to get money is not to work for it, but to fight for it." When that idea has taken possession of a sufficient number, the power of existing enacted laws to protect the right to such property will fail. The destruction of one class of property to satisfy demands not correctly based on the natural law of justice will not satisfy, it will only stimulate the anger of the misguided. A well defined movement in a wrong direction cannot be stopped until it has gone far beyond the limits originally assigned for it by those through whose ill-judged work its inception and momentum are due. On the day when those having false conceptions of the principles of justice gain control of the government, municipal, State or national, calamity will come. The falsity or correctness of any person's conceptions may be shown by his ability or disposition to recognize the right to property in an idea. This is the kind of property most difficult to protect by law; therefore it is the most easily stolen. A man who will steal because he safely can is honest or just only when he must be. A man who is honest or just only by compulsion has not the spirit of honesty or justice in him.

AN ECONOMIC DELUSION.

All men are endowed with equal natural rights, but not with equal natural conditions or capabilities. The teaching that "All men who do their best do the same,"* is an economic delusion. No one more readily recognizes differences in capabilities than honest-hearted, clear-headed men who work under the direction of others.

Whatever a person may justly claim is his by right, not by favor. Less than this no man should be permitted to demand or receive. What one cannot give in justice to himself, another cannot justly take from him. Justice to self is a true measure of justice to others. The divine command is, "Do unto others as you would have others do unto you." This command requires every man to be sure that his own acts are just, rather than to be the judge of the actions of others by demanding justice for himself. No man can comply with this command without doing justice. No man can obey this command who fails to recognize the differences in natural or acquired capabilities existing between himself and others.

The history of mankind presents a panorama of the rise and fall of civilizations. Men have ever been reaching after but have never fully grasped and comprehended the great truth which teaches the twofold character of the products of life—character and property. The greater always includes the lesser interest, yet men for ages have blindly sacrificed character for the sake of property. Every feature of the economic law of labor and property must be correctly understood and rightly obeyed before a person can develop the best possible character. Moral law is the foundation of economic law. Economic law completes moral law. One cannot be rightly observed while the other is being violated.

THE TREASURES OF WISDOM.

All that has been said pertains to ideas that may be made tangible, imprisoned in concrete forms and offered for sale in the market place. They are of the earth. Beyond them, enveloping them, as the earth is enveloped by its atmosphere, is the realm of thought. There the society of mind exists; a society in which property is unknown. There the wise of all ages hold communion. There consent is given not to own, but to freely take all that any one is capable of receiving. None can hear the conversation of the wise who cannot understand them. In that society the property values for which men so earnestly contend have no meaning. The treasures of wisdom need no guarding. They elude destruction. They increase by being shared. In the realm of the society of mind it is clearly understood that the things of greatest value are priceless. There no one will sacrifice character for property. There one would be known as a loser who should give his character, his soul, in exchange for the whole world. What infinite folly is it then for practical business men to risk an impairment of character to gain even the largest wealth any one has ever been able to grasp. No man can be unjust to a fellow-man and wrong him out of the enjoyment of anything that is justly his without blindly sacrificing the greater for the lesser good. All so inclined should know that it is impossible for the justice of God, which overrules the affairs of men, to permit any one to be a permanent gainer by acts of his own injustice. In the name of all who labor, justice is demanded by all who wisely, or unwisely, work for social reforms. For the welfare of all who toil with hands or brain, let every one be taught to be just. When all are just, the right to property in ideas, or in any other form, will need no guarding, no affirmation.

The Berlin correspondent of The Times has given some particulars of a new invention by one Carl Wegener, which has for its object the elimination of smoke from a furnace, accompanied by a notable saving in the consumption of coal. The success of the system depends upon feeding the furnace with powdered coal, instead of the "well-screened" lumps which have hitherto been regarded as the most advantageous form of such fuel. The coal-dust is fed into the fire from a container in front by means of a tube which terminates in a revolving sieve. This sieve is kept in motion by the draught, and has the effect of scattering the fuel over the furnace in such a way that it is at once inflamed without smoke and with very little ash. Coal of comparatively low quality can be economically used in this powdered form, and the only drawback to the process seems to be the necessity for using a separate machine for the grinding of the coal to powder. On the other hand, the slack or dust which forms a necessary by-product of the coal industry will find here a field for employment which will be much appreciated by owners of mines and merchants generally.—Chambers's Journal.

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* "The Law of Incorporated Companies Operating Under Municipal Franchises." See chapter under the title of "The Economic Law of Labor and Property." Robert Clark Company, Cincinnati, O.

* "Equality." Edward Bellamy.

ENGINEERING NOTES.

A recent issue of the Centralblatt der Bauverwaltung states that the total length of track in operation in Germany was 28,626 miles of standard gage and 817·5 miles of narrow gage. During the year there were 487 derailments and 281 collisions, and in these accidents 762 persons were killed and 1,969 injured. These figures for accidents, which probably include all casualties in switching and coupling cars, show an increase over previous records.

A large brick chimney, measuring 85 feet high, 7 feet square at the base, and 4 feet 6 inches at the top, and weighing about 130 tons, was recently moved bodily 1,000 feet over rough ground at Manhanset, Shelter Island, New York. The chimney, according to Power, has a 30-inch flue, with an 8-inch wall on the outside and an 8-inch round inner wall for the flue, connected with the outer wall by three or four bricks at intervals of 10 feet. Starting from the old site, the first 100 feet was up an incline of about 3½ feet, and at that point was the only piece of ground that the skids were both on single blocking. From that point the blocks were increased to as much as 5 feet high on both sides. The cradle rested on two skids greased on the under side and sliding on greased blocks. A chain purchase was used, with one horse on the capstan, the ratio movement being 150 to 1.

A recent issue of the Revue Pratique des Travaux Publiques gives some particulars of the large sewage farm which has been laid out at Achères for purifying the Paris sewage before allowing it to pass into the Seine. The inhabitants of Paris number 2,500,000, and the total flow of sewage is stated to average 17,660,000 cubic feet per diem. This is collected in great intercepting sewers, which convey it by gravitation down to Clichy, where it is raised 118 feet by powerful pumps and distributed by gravitation through the farm. The pumping engines at present installed are capable of indicating 1,200 horse power in the aggregate, but future additions will raise this to 6,000. It is stated that experience shows that one acre of suitable soil can take 1,580 cubic feet of sewage daily, so that an area of about 11,120 acres would be needed to deal with the whole of the discharge of the Paris sewers. A very high degree of purification is reached, the effluent containing fewer bacteria per cubic centimeter than most uncontaminated streams. The land also has been greatly increased in value, being now worth five times as much as it was before being made a receptacle for the sewage. As a natural consequence, neighboring land owners, who originally had fiercely opposed the establishment of a sewage farm in their midst, are now demanding to have the sewage supplied to their own properties. The farm at Achères is 2,471 acres in extent, and is under the control of M. Bona, a civil engineer, who in the main raises beet root, though this crop will admit of much less sewage being passed on to the land than certain others. The main conveying the sewage from the pumping station is 43·2 inches in diameter, while a secondary system of pipes, ranging from 31 inches to 16 inches in diameter, serves as feeders to the irrigation trenches, into which the sevage passes through 11½ inch valves. The ground is laid out and the irrigating trenches are so arranged that the only service needed in regulating the flow is the opening or closing of the regulating valves just mentioned. The crop which can stand the most sewage is grass, a meadow being, it is stated, uninjured by a flow of 2,430,000 cubic feet per acre per year; lucerne can take 1,790,000 cubic feet per annum; artichokes, 593,000 cubic feet per annum; flowers, parsley, sorrel, etc., 536,000 cubic feet; leeks, cabbages and celery, 325,000 cubic feet per annum; while beet roots, carrots and beans will take only 197,000; and potatoes, asparagus and pease but 141,000 cubic feet per acre per year.—Engineering.

The German railway authorities have of late years shown much energy in improving everything connected with the German system, and to no part of the service does that praise apply with greater right than to the stations. Any number of railway stations have, during the last five or ten years, been either extended or completely rebuilt, the centralization of the railway traffic and an endeavor to interfere as little as possible with other traffic having apparently been the leading principles. Not only are the German railway stations, as a rule, commodious and well arranged throughout, but large sums have also been expended upon their exterior, and even a number of medium sized towns now boast railway stations of considerable architectural beauty. Level crossings have, wherever possible, been done away with, and this has generally been brought about by elevating the railway, so that at many stations the platforms are at a comparatively high elevation, on a level with the first floor of the stations. Some of the large new German railway stations are simply models of excellence; for instance, Cologne and Frankfort, and several other large railway stations are being transformed at a very heavy expenditure. The Wiesbaden railway station will, for instance, cost some £1,200,000, and two of the Berlin railway stations, the Stettin and the Silesia stations, will each cost close upon £500,000. Also at Essen, Crefeld and Coblenz new railway stations are being built or old ones altered, the expenditure averaging some £300,000 for each town. The most expensive railway station is the one at Dresden, where the calculated expenditure of some £1,700,000 in all probability will be exceeded by some 60 or 70 per cent, before the whole installation is completed. Also several other railway stations have entailed heavy expenditure; the Frankfort railway station has, for instance, cost £1,750,000, the one at Cologne over £1,200,000, the one at Hanover £1,000,000, the Mayence railway station £900,000, and those at Düsseldorf and Munich £800,000 each. The dimensions of some of these railway stations are quite out of the common. At Frankfort there are 18 platforms, covered over a length of over 600 feet by a three-arched roof structure, their aggregate width being about 600 feet. At Munich there are 16 platforms, or rather lines of rails, covered in by four arches, the length and aggregate width of which are respectively about 460 feet and 500 feet. At Mayence the station is long and narrow, and at Düsseldorf there are 10 lines, the hall being over 550 feet long and about half as wide. Work at present in course of progress on the Prussian state railways amounts to close upon £7,000,000.—Engineering.

MISCELLANEOUS NOTES.

"President Stuyvesant Fish, of the Illinois Central Railroad," says The New Orleans Picayune, "celebrated a most important event in the history of his road, as well as in the commercial history of this city, by presenting to Secretary Hester, of the Cotton Exchange, the bale of cotton which completed the 1,000,000 bales of the fleecy staple brought into this city by the Illinois Central Railroad during the eight months of the present season. To have handled into this city 1,000,000 bales of cotton in a single season is an important and unprecedented feat for a railroad company, but even that round million does not fully represent the amount which will be handled by the same company for the entire season, as four months of the year have yet to elapse. The transportation of these 1,000,000 bales required in round figures 25,000 cars, or about 833 average freight trains."

The expensiveness and lack of durability of rubber water and ice bags has led to much fruitless research to discover an efficient substitute for rubber. Prof. Jacobsohn announces that the Japanese rice paper articles of the kind are a distinct advance in the technique of the care and comfort of the sick. They are made of several layers of the soft, flexible rice paper used for many purposes in Japan, with resin between, finished on the outside with a coat of the famous Japanese lacquer. He exhibited some air cushions thus made, at the meeting of the Berlin Society of Internal Medicine, demonstrating that the cushions were absolutely airtight, flexible, "featherlight," remarkably enduring, bearing a permanent weight of 150 kilogrammes, folding into extremely small compass when not in use and costing less than a sixth of the corresponding rubber articles now in use.

In the Zeitschrift für Angewandte Chemie, C. O. Weber writes on the analysis of vulcanized rubber by boiling the finely powdered material with nitro benzol. The solution is diluted with ether, to separate the anorganic from the inorganic compounds. One rather abnormal analysis gave, e. g., 8·35 per cent. of oily extract, 9·85 of rubber, 16·8 of carbon, 1·9 of sulphur, and 63 per cent. of mineral admixtures. As a rule, the oily extract amounts to only a third of the quantity stated. The formation of so much extract, which is inconvenient for further analysis, can be avoided by first treating the rubber with chloroform, which causes it to swell. The chloroform further reduces the boiling point of the solvent from 208° C. down to 180° to 170° C. It is known that rubber splits on heating almost quantitatively into hemiterpen, polyterpen and dipenten. In vulcanized rubber, decomposition takes place at about 200° C., but of what nature is not settled yet.

While lightning may be seen and its illumination of clouds and mist may be recognized when it is even 200 miles distant, thunder is rarely audible more than ten miles. The thunder from very distant storms, therefore, seldom reaches the ear, says Industries and Iron. The reason of the great uncertainty in the audibility of thunder is not difficult to understand. It depends not merely on the initial intensity of the crash, but quite as much on the surroundings of the observer, even as in the quiet country one will observe feeble sounds that escape the ear in a noisy city. Perhaps the most curious and important condition of audibility is that the thunder wave of sound shall not be refracted or reflected by the layers of warm and cold air between the observer and the lightning or by the layers of wind, swift above and slow below, so as to entirely pass over or around the observer. Sound, in its wavelike progress obliquely through layers of air of different densities, is subject to refraction, and this refraction may occur at any time and place. Thus, observers at the topmast of a ship frequently hear fog whistles that are inaudible at sea level; those on hilltops hear thunder that cannot be heard in the valley; those in front of an obstacle hear sounds inaudible to those behind it. The rolling of thunder, like that of a distant cannonade, may be largely due to special reflections and refractions of sound. Again, the greater velocity of the air at considerable altitude above the ground distorts the sound wave and shortens the limit of audibility to the leeward, while increasing it to the windward.

Manila hemp is the fiber of a species of banana (Musa textilis) which thrives only in certain localities, where it is cultivated by the natives, says Bradstreet's. The fiber is still produced in the old native way, by scraping the leaves with a peculiar knife, which requires expert handling. Numberless contrivances to supersede this simple process have been tried and patented, but without success. The native way is still the best, and it produces a fine fiber of which thread is spun and cloth woven that excels the best Tussore silk. Manila hemp is one of the leading products of the Philippines and it represents one of the most important industries of the islands. The superior qualities of the material are well known to the seafaring men of all nations and to those connected with hempen industries everywhere. It is exported to the United States, Great Britain, Continental Europe, Japan, China and Australia. Forty-one per cent. of the export trade is with the United States, the value for the year 1897 being $2,701,651. The following table, as reported by the American consul, gives the total and destination of hempen exports for the years named:

HEMP EXPORTS, 1888–1897.

	Great Britain. Bales.	United States. Bales.	Continent of Europe. Bales.	Total. Bales.
1888	347,854	246,437	2,861	597,152
1889	322,022	199,706	1,239	522,968
1890	341,993	109,726	1,968	453,687
1891	443,142	132,267	4,206	579,615
1892	357,744	384,076	3,354	745,174
1893	373,041	212,463	3,548	589,052
1894	335,372	387,045	11,691	734,108
1895	493,801	273,918	3,981	771,700
1896	407,522	290,327	2,632	700,481
1897	385,182	417,473	23,373	825,028

As the Philippines are at present the only source of supply of Manila hemp, it is likely that future trade in that product will grow in large proportions.

SELECTED FORMULÆ.

Essence of White Clover.—

Vanillin	20	grains.
Heliotropin	30	"
Coumarin	20	"
Tincture of storax	½	ounce.
Tincture of civet	½	"
Tincture of orris	1	"
Otto of rose	60	minims.
Oil of bergamot	60	"
Oil of neroli	90	"
Extract of tuberose	4	ounces.
Extract of jasmin	8	"
Oil of cloves	5	minims.
Oil of bitter almonds	5	"
Terpineol	60	"
Rectified spirit	8	fl. oz.
Glycerin	1	fl. dm.

Essence of Crab Apple.—

Hyacinthin	5	minims.
Cratægin	10	grains.
Oil of ylang ylang	30	minims.
Volatile oil of nutmeg	10	"
Oil of lignaloe	20	"
Oil of wintergreen	2	"
Musc Baur	10	grains.
Extract of cassie	2	fl. oz.
Extract of violet	4	"
Tincture of orris	1	"
Glycerin	30	minims.
Extract of jasmin	4	fl. oz.

Essence of White Iris.—

Ionone	3	minims.
Oil of orris	10	"
Heliotropin	30	grains.
Terpineol	60	minims.
Oil of ylang ylang	20	"
Oil of lignaloe	5	"
Solution of amyl acetate, 10 per cent	5	"
Glycerin	20	"
Essence of jasmin to make	10	fl. oz.

Essence of White Violet.—

Ionone	60	minims.
Musc Baur	10	grains.
Essential oil of orris	10	minims.
Extract of violet	18	fl. oz.
Extract of rose	2	"
Oil of sweet orange	5	minims.
Oil of lignaloe	5	"
Solution of amyl acetate	5	minims.
Heliotropin	30	grains.
Terpineol	5	minims.
Solution of oil of patchouli (1 in 10)	20	"
Glycerin	30	"

Essence of Wallflower.—

Essential oil of orris	2	minims.
Oil of sweet orange	1	"
Heliotropin	5	grains.
Oil of neroli	2	minims.
Extract of orange	2	fl. oz.
Extract of tuberose	2½	"
Extract of jasmin	15	"
Coumarin	3	grains.
Glycerin	30	minims.
Oil of bitter almonds	5	"

Essence of Heliotrope.—

Heliotropin	30	grains.
Essence of jasmin	4	ounces.
Oil of ylang ylang	5	minims.
Oil of bitter almonds	2	"
Cratægin	1	grain.
Oil of neroli	10	minims.
Oil of lignaloe	30	"
Terpineol	10	"
Otto of rose	5	"
Rectified spirit	10	fl. oz.

Essence of White Lilac.—

Terpineol	3	drachms.
Heliotropin	30	grains.
Extract of rose	2	fl. oz.
Oil of ylang ylang	10	minims.
Extract of jasmin	4	fl. oz.
Rectified spirit to produce	20	"

Essence of Lily of the Valley.—

Extract of tuberose	6	ounces.
Extract of jasmin	8	"
Tincture of civet	1	"
Oil of lignaloe	30	minims.
Terpineol	10	"
Oil of sweet orange	2	"
Heliotropin	20	grains.
Oil of neroli	3	minims.
Glycerin	20	"
Tincture of chlorophyl	30	"
Extract of rose to produce	20	fl. oz.

Essence of Narcissus.—

Caryophyllin	10	minims.
Extract of tuberose	16	fl. oz.
Extract of jasmin	4	"
Oil of neroli	20	minims.
Oil of ylang ylang	20	"
Oil of cloves	5	"
Glycerin	30	"
Solution of amyl acetate, 10 per cent	20	"

Essence of Wood Violet.—

Ionone	10	minims.
Extract of violet	18	ounces.
Extract of cassie	4	fl. oz.
Extract of jasmin	4	"
Tincture of orris	10	"
Tincture of musk	20	minims.
Otto of rose	5	"
Glycerin	30	"

—Pharmaceutical Era.

Gold Solder.—According to Dr. Beebee (Dental Cosmos), dental solder may be obtained by melting fine copper, 53 parts; fine silver, 25 parts; and pins, 12 parts. By the addition of fine gold, any desired carat may be obtained. If very high carat solder is wanted, the author uses less alloy and substitutes more fine silver.—Zahnt. Reform, xvii., 451.

[Continued from SUPPLEMENT, No. 1174, page 18796.]

THE CAUSES OF THE EXPLOSIVE EFFECT OF MODERN SMALL CALIBER BULLETS.

By CHARLES E. WOODRUFF, M.D., United States Army, Jackson Barracks, New Orleans, and published in The New York Medical Journal.

EXPERIMENT VIII.—Can of tomatoes, having only a small bubble of air. An effort was made to get all air out, but unsuccessfully. Results same as Experiment IV., except that the exit opening was larger, being over two inches in diameter, and there was greater bulging of both ends and slighter collapse of sides than in Experiment IV. These two, Experiments VII. and VIII., show that a semi-solid or partly solid material floating in water acts justs as the pure water. The effect on the skull is also the same as though the skull were filled with water instead of a semi-solid floating in water. In each case the water transmits the vibrations and pressure.

Experiment IX.—Can of tomatoes. It was opened to the air by numerous holes punched in the upper side. Bullet passed through near the bottom. The entrance hole was small, as before, but one-half of its edge was inverted and the other half everted, showing that the dragging in of the edge by friction of the bullet was reversed subsequently by a pressure after the bullet had entered the contents. Front end bulged out, as in Experiments IV. and VIII. An inch and a half of the lower soldered edge near bullet entrance was blown out and the adjacent side collapsed. Rear end badly bulged out, exit opening very large. One-half of soldered edge torn loose and sides collapsed. But little injury occurred at the top, where there was freedom of air movement. As the bullet passed through near the lower edge, this was collapsed by the return wave, for here the return movement began so soon, the particles having so little distance to travel. This side was first flattened against the wooden block on which it rested before it collapsed, and it has the same transverse ridges seen in Experiments VI. and VII.

Experiment X.—Can of tomatoes. This was freely opened to the air by removing a strip nearly two inches wide at upper side. This was done to show that it could not possibly be hydrostatic pressure (fluid at rest), but hydrodynamic (fluid in active motion). If it were simply transmitted pressure, the fluids had plenty of opportunity to escape. Entrance opening small, front end bulged out, rear end badly bulged out and nearly one-half of edge torn loose. Exit hole smaller than in previous experiments, being scarcely an inch in diameter, but it had the same jagged, everted edges. The strength of the can was, of course, greatly reduced, and the sides bulged badly at top, where strip was removed. It was flattened against the wood, but did not have the transverse ridges as in Experiments VI., VII. and IX. The free opening to the air at top, of course, allowed all the upward-moving fluid to escape, bulging the sides as it did so; consequently, there was no return motion and collapse, for the air rushed in to equalize the pressure and take the place of the vacuum left within.

In the next experiment a wooden box with a glass side was constructed, to find out whether it was possible to observe through the glass the wave produced by the bullet; but we signally failed, as the pressure produced was more than the box could stand. It was burst into pieces, and the damage was done so quickly as to make no impression on the retina. The box was twenty-four inches long, twelve inches wide and ten inches high; it was open at the top and was filled with water. The bullet went through from end to end, in the front making a small hole the size of the bullet, but in the rear end tearing out a conical space three-fourths of an inch by an inch and a half at anterior surface and an inch and a quarter by two inches and a half at rear surface. The rear end was blown off in two pieces after the bullet went through, and rebounded ten feet from the target butt. The bottom was split into five pieces, the central one being further broken at the center, as though it had been bent outward. The nails at the rear end of the box were not bent at all, or slightly bent to the rear. At the front end, the sides were blown outward about half an inch, but more at the bottom than at the top, as the bullet went through near the bottom. The glass was broken into fragments and thrown outward, some pieces as far as thirty feet. We had here the very severe action of the first wave produced by the cavitation behind the bullet, the effect increasing in violence as it proceeded from front to rear. It would be interesting to have the same experiment performed in a large tank.

It is evident that the new small caliber bullet produces exactly the same effects as the older, slower ones, only more of them. In order to show this, we will detail three other experiments with the slow-moving bullet from the army pistol fired into other cans.

Experiment XI.—Can full of water, sealed. Entrance hole small, cut out and edges inverted; exit hole about half an inch in diameter, jagged and everted. Both ends bulged out, and the longitudinal seam burst open. No collapse. There was here a similar increase in volume from cavitation, but the return trip of the first wave was not of sufficient force to cause the sides to collapse. Possibly there were fewer vibrations, and the vacuum made by the bullet was of small extent.

Experiment XII.—Can full of water, a strip being removed from upper side. The bullet was fired very low. Entrance and exit same as Experiment XI. Front end but slightly bulged, rear not at all. Upper edges of slot everted, but lower side collapsed. The outward wave everted the edges, but free ingress of air prevented collapse. At the bottom, on the other hand, the vacuum was close to the wall, and the tin collapsed at once at the return vibration, the same as in Experiments VI. and IX.

Experiment XIII.—Same as Experiment XII., and same results. The collapse in both these cases is very instructive, for the tin sides were forced up to and beyond the track of the bullet, as in Fig. 3.

To show that the direction in which the bullet is fired through the can is immaterial, in the next experiment the can was shot through from side to side. We might hear the objection that the blow on the solid end may of itself cause the pressure within. This objection could have been answered a priori by the fact that the bullet cuts its way into the can without disturbing the metal walls, as it overcomes the cohesion of those particles it comes in contact with before the inertia of the rest can be overcome, and cuts out a piece like a punch.

Experiment XIV.—Can of water. Bullet entered the sides and went through parallel to the ends. Entrance hole small and "punched out," with slightly inverted edges. Exit opening large, almost square, an inch and a half to the side, with ragged, everted edges. Can bulged out at ends and bulged out on entrance side, even tearing the metal in a strip running through entrance hole. The upper end was ripped half off and swung upward forty-five degrees.

Experiment XV.—Can full of dry sand. This experiment was tried, as the sand acts somewhat as a fluid. Entrance small, as in the other cases. Exit about an inch in diameter, with ragged everted edges. The bullet made a funnel-shaped tunnel from one opening to the other, its sides being of compact compressed sand.

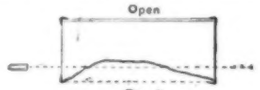


FIG. 3.

The can was not bulged out in the least. This shows that the sand particles flying away from the bullet were merely embedded further in or "packed," and could not transmit their pressure to the sides of the can. At the exit they bulged out the torn edges just as the water did.

Experiment XVI.—Can full of wet sand. Here was a semifluid capable of transmitting pressure, practically incompressible. The results were nearly the same as with water—i. e., very severe bursting effects, with tearing of can. The front end was slightly bulged, the rear end was torn entirely off. The sides of the can were collapsed into oval shape.

In Experiment VI. the outward movement of the water above the bullet track had no effect upon the can, because the compressible air took up the pressure and distributed it evenly. If this were an intestine or stomach partly full of fluid and gas, we can see how the parts inclosing the fluid might be frightfully lacerated and those surrounding the air entirely escape.

The wave increases in force as it advances, because the further the bullet goes, the thinner is the layer of fluid in front of it and the more easily can it move the whole mass; consequently, but two of the cans have the seams on the front end burst out (Experiments VI. and IX.), but the rear end is invariably badly torn open.

In order to apply all these results to organs, we made the next four experiments with fresh bladders from recently killed cattle.

Experiment XVII.—Bladder distended with air. The bullet went through, making a tiny hole of entrance and exit, and scarcely moved the bladder.

Experiment XVIII.—Bladder half full of water and half of air. The first bullet went through just at the water's edge, making small entrance and exit wounds. The second bullet went through the water. The entrance and exit wounds were very large lacerations, three to four inches in diameter, the bladder being turned inside out.

Experiment XIX.—Bladder full of water. The entrance and exit wounds were both very large and torn. Soldier who fired the shot, and who knew absolutely nothing of the essence of this paper, volunteered the information that he saw a momentary swelling out of the bladder before it collapsed. Two other spectators who were looking for this phenomenon could not assure themselves that they saw it. It takes place so quickly

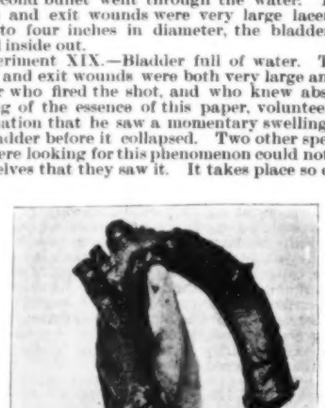


FIG. 4.

that unless one knows exactly when it occurs it makes no impression on the retina. Spectators are guided by the sound of the firing, which cannot possibly reach their ears until after the bullet has passed through. The soldier, on the other hand, knew exactly when to look, for he was the active agent in causing it. Perhaps the cinematograph would recall the ballooning of such experiments.

It should be said that in all the above experiments, when fluids or semifluids were used, the cans were thrown off the block, sometimes six or eight feet, and some of them bounding in the air. The bladders were also thrown from their supports. Cans full of air were, of course, unmoved, as was also the bladder which was distended with air.

These experiments prove the futility of experiments upon dead animals, for after rigor mortis sets in we have such a complete change in the fluids of the body that we may not have any explosive effect at all from wounds that would have been remarkably severe in the living tissues. Again, bones are freely movable in the living and can take up vibrations which they could not do when fixed in position by rigor mortis. A live joint full of fluid will, of course, balloon out like the skull, heart, or the tin cans.

The photograph, Fig. 4, shows how these vibrations taken up by the blood in the heart can burst the organ open, a result manifestly impossible by hydrostatic pressure, for by the latter there would be a tear or rent and not an effect as though dynamite had exploded from within. The photograph (Fig. 4) is of the heart of a man who committed suicide by shooting himself with the new Krag-Jorgensen rifle, and being at such short range it, of course, shows the explosive effect with frightful distinctness. The horizontal white line is a slender strip of paper laid in the track of the bullet as it went from front to rear through the left ventricle. The vertical white lines are strips of paper laid in the left auricle and left ventricle respectively. It will be seen that the whole left heart has been blown open from within outward—a veritable explosion. The whole picture is an immense open lacerated wound involving the whole auricle and ventricle. The right heart was not involved. A more typical illustration of the explosive effect of the new bullet when it strikes a live organ full of fluid (not a dead one) could not be obtained, and it is probably unique.

The following experiments on bones are of interest, taken in connection with the effects produced on the can of sand. The tibia of a horse was suspended by a string tied to a nail driven in one end. It was shot transversely in various places. At the spongy ends the bullet went through, making a tiny track, but no tearing. At two and four inches from the end, though still in spongy tissue, but with thicker walls, the track was conical, of the size of the bullet at entrance, but half an inch to an inch in diameter at exit, with no further destruction of the bone. This was exactly as in the can of dry sand. Six inches from the end the bullets tore off many fragments of bone from one side only. A shot fired very nearly through the center of the bone broke it in two pieces by tearing out a length of an inch and a half, which was shattered into fragments. This might have been expected, for it is at the center that vibrations could be taken up in their greatest intensity.

We must not confound the explosive effects of the bullet with the lacerations due to ragged, deformed bullets. Here we have to do with a serious tearing of muscles and ligaments. Lacerations are, of course, greatly increased by particles of bone broken off and forced forward acting as so many new missiles. In a recent case the bullet carried with it many fragments of the lower end of the humerus, and together they tore an immense opening in the forearm. They acted like a charge of buckshot, or the "sand-blasting" of snipe, whereby pot hunters can kill a large number of birds at one shot by firing into the sand in front of the flock. It was not an explosion. In joint wounds these two forms of action are seen simultaneously.

The pulpifying effect of large projectiles which pass close to a limb without touching it is a phenomenon similar to the explosive effect of small bullets. Though the skin may be uninjured, the tissues within may be pulpified beyond recovery, and death may result unless amputation is performed. It has been said to be due to "windage" or effects of the air pressure. It is probably due to the air vibrations, which, so close to the projectile, must be of immense power.

Among other theories as to the cause of the explosive effects of the bullet is the assumption that it becomes very hot. This is a very remarkable misstatement. The bullet's temperature is altered but very little, either by the momentary contact with the flame or by friction of the barrel, or friction in the air, for experiments with infected bullets show that the bacteria are not killed, as they would be if the temperature were raised to any extent, but can infect animals into which they are fired. Nor is the heat due to impact very great. Some writers assert that this heat is sufficient to melt the bullet, and that deformation of the bullet is due to the melting of the metal. The total muzzle energy of the bullet is shown to be many times less than sufficient to melt the metal. The bullet is flattened mechanically, as we would flatten it with a hammer and anvil, its cohesion being overcome mechanically and not by heat. Heat has positively nothing to do with the explosive effects of the bullet. The increased volume of the cans shown by the bulging of sides and ends, as in Experiment XI., is not an increase due to heat, for the water would not expand so much under influence of heat, and there is not enough energy in the bullet to produce steam in bulk equal to this increment of volume. It is a cavity around and behind the bullet, and the volumetric increase of the cans is explainable under no other reasoning. It is "cavitation," as explained by marine engineers.

It has been stated that the explosive effect is due to the rapid rotation of the bullet received from the rifling of the barrel. All the effects I have detailed are explainable without taking rotation into effect at all. In order to disprove it conclusively I fired several shots from a smooth-bore shotgun, using a round 0·45-caliber bullet. This bullet undoubtedly may receive a rotation from sliding along one side of the barrel, but this is a tumbling rotation around a transverse axis, and, in addition, it is so slight that in comparison to the rapid rotation due to rifling it can well be neglected.

Experiment XX.—Can full of water, top partly open. Entrance and exit openings about three-quarters of an inch in diameter, with inverted and everted edges respectively, both ends slightly bulged out.

Experiment XXI.—Can full of water, top partly open. Entrance opening about three-fourths of an inch in diameter, with inverted edges. Exit opening an inch by two inches and a half, everted, torn edges. Both ends of can were bulged outward. The flap on the top end was bent out ninety degrees by the escaping water. The difference in the extent of explosion in the two above experiments was probably due to the amount of gunpowder used.

Experiment XXII.—Can half full of water, shot fired through air strata. No bulging of can. Exit and entrance opening each about an inch in diameter, with inverted and everted edges respectively. The large size of the entrance opening in each case is, of course,

due to the slowness of the blow giving time to bend and tear the tin, instead of punching out a piece, as the rapidly moving bullet does.

In the accompanying photograph (Fig. 5) of these tin cans many of the facts mentioned are quite clearly shown, the numbers corresponding with the numbers in the experiments. In No. 1 is the small entrance hole, while in No. 2 is the exit. Nos. 3, 4 and 5 show the exit ends. Nos. 6, 7 and 8 are the transverse views, No. 7 showing the ridges received from the block. Nos. 9 and 10 are the exit ends. Nos. 11, 12 and 13 are the transverse views. No. 16 shows the exit. No. 15 shows the exit from the sand. No. 20 is the exit. Nos. 21 and 22 the entrance.

Explosive zones are said to exist. For instance, it is thought that in the middle ranges, say from five hundred to eight hundred yards, the explosive effects are not found, or are not so marked as at shorter or longer ranges. The writer believes such ideas to be errors from the accidental finding of cases in the middle ranges which had not been wounded in fluid tissues or in such parts of solid tissues as would allow of vibrations being taken up. It can be proved, of course, by firing into tin cans at different ranges.

Unfortunately, the writer is not so situated that he can do this now, nor can he procure cartridges with reduced charges, as the ordnance department of the army no longer makes such cartridges on account of the uncertainty of their action.

It is quite evident, then, that the whole subject is a

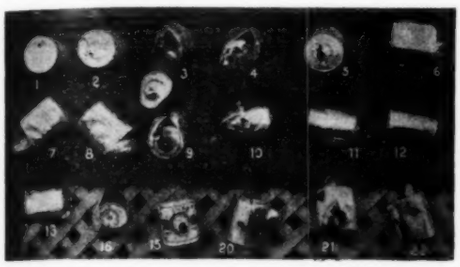


FIG. 5.

wonderfully complex one, but due to well known mechanical laws of vibrations or wave motions. Of a line of infantrymen fired at and shot, some will be so little injured as to go on fighting, while others will be instantly killed, with frightful mutilation. The bullet has stopping power if it hits the right spot, but to stop an approaching enemy we have to mutilate him so badly that he dies instantly. This is opposed to the genius of modern war, which aims to stop the enemy's fighting by injury and to avoid killing him if possible. Death is only a last resort. With the new bullet the only way to stop him is to kill him—this is barbarism. In the next place, unless we do kill him he may keep on advancing after receiving a fatal wound and kill us before he falls, actual cases having occurred in India.

In the third place, to stop him with this bullet is a haphazard thing, too uncertain for the precision necessary in war. We must be certain that the great majority of the men struck will be out of the fight instantly, whether fatally wounded or not. Military men are beginning to feel that the new rifle is unfit, except for the sharpshooters to use at long range, and are wondering whether, after all, they will not have to return to the large caliber again for the body of the army, who will do their effective fighting at short range. They argue that the average man cannot shoot accurately at long range, and why give him a precise instrument which he cannot use? The objection to all this is the confusion which results from having ammunition of different calibers for the field. Perhaps the objection is not so weighty as the objections to the present uncertain arm; better some confusion, which only affects a few sharpshooters, than defeat. Perhaps the next army rifle will be of large caliber, slower velocity and surer stopping power.

It is somewhat foreign to this paper to explain why the old, large-caliber, slow-moving bullet had such greater stopping power and caused so much damage every time it was stopped in the body. It has partly to do with the energy of the bullet and its momentum. The energy or ability to do work is proportional to the mass and the square of the velocity (MV^2); hence the new bullet, though smaller, has much greater energy than the old, and can do more work, though it rarely gives up all its energy, because it passes entirely through the body. The blow struck depends entirely upon the momentum, which is proportional to the mass and velocity. The slow, large bullet can have greater momentum, even though it has less energy, than the new. In addition, it is so large it cannot plow its way through the tissues like a small bullet, as it has to tear apart so many more cohering particles. It is therefore stopped, gives up all its energy and delivers a far greater blow than the new bullet.

It is self-evident that a bullet must lose its energy very greatly and very rapidly by producing cavitation and wave motions in fluids. To prove this seems unnecessary; nevertheless, the following experiments were made. Several boxes, fourteen by eighteen by twelve inches, were filled with water and placed in line end to end about sixteen inches apart and fired into at the end of the line. The first bullet fired low burst two boxes, but did not have enough energy left to penetrate the third. It passed partly in, caused a wave, which separated the joints here and there a quarter to half an inch, and then dropped harmlessly to the ground. The second bullet burst two boxes, but was deflected in passing through the second one and was lost. The third bullet was fired high and skimmed along the surface of the fluid, making a shallow trough of water, lost but little energy and went through the rear end, making a tiny hole, as it did in the front end, and then buried itself in the target butt. The box was uninjured.

These experiments show that while the new bullet may go through twelve men or more if it does not strike fluid tissues, it can go through but few if it loses energy by exploding fluid-containing organs like the heart, bladder, etc.

It is to be hoped that all experiments hereafter made on living animals, as well as accidents happening to man, will be interpreted on the grounds laid down in this paper. We should consider the velocity of the bullet, the character of the tissues, whether solid, fluid or gaseous, and their capability of taking up vibrations; the cavitation in fluids, lacerations by deformed bullets in semi-solids, and, finally, the wounds made by pieces of solids torn off and converted into additional missiles.

VARIATIONS IN THE FORM OF THE HEART.

THE heart once played a great part in popular beliefs: it was the most noble of the viscera, and was also the most sensible, and it modified itself according to the state of the subject's soul; hence the expression "to be big-hearted."

The heart has now lost its ancient prestige, the errors on the subject of it have passed away, and it is found that only the idea of the change of volume has persisted—a notion that our improved processes of investigation show to be well founded.

It was not very long ago that the discovery was made by direct observation that the heart easily changed in form. Various German investigators, along with Gendrin, Constantin Paul, Potain, and G. Sée in collaboration with Pignol (about a dozen years ago), have, through percussion, been able to demonstrate that the heart readily changes form and position, and dimensions even, under a series of varied influences that all act upon the nervous system. Such changes are so much the more sharply defined in proportion as the subject is more nervous.

But the above-named investigators had at their disposal only percussion, a process easily carried out by striking with the ends of the fingers of the right hand the dorsal face of the index applied with a strong pressure upon the skin at the point that it is desired to examine. The differences in tonality thus obtained by percussion may serve to fix the limits of the subjacent viscera.

For this primitive process we have substituted the use of the Capitan and Verdin stethoscope, in bringing into play the Bianchi phonendoscopic method.

In all our researches, we have fixed the boundaries of the heart without figuring the complete outline of the auricles and ventricles. The method has been that indicated in a preceding article, and the technique of which is very simple. In the first place an impressionable or intoxicated subject is selected. In this case the results are more marked.

Moreover, with almost everybody, the form of the heart varies very easily under various functional or pathological influences; after some effort, such as running, after a meal, after exposure to a sudden cold (such as shower bath), etc. A number of diverse influences may predispose the subject to have such special sensitiveness of the cardiac nervous system—anæmia, any nervous state whatever, a general malady (acute or chronic), or even simply a diathesic state, such as rheumatism or alcoholism, etc. It will be seen, therefore, that there are very few subjects of which the form of the heart never varies. Such rare individuals are very healthy, strong, and but slightly emotional.

The following, then, is the process that we have employed for examining the variations of the heart. The subject being made to stand, the outlines of his heart are found by the general method of phonendoscopy. This method, as our readers will remember, consists in applying the button of the stethoscope to about the center of the cutaneous area, corresponding to that occupied by the heart, and in rubbing the skin gradually from this point. When, by means of the rubber tubes connecting the apparatus with the ears, the sound of the rubbing is no longer heard, the limits of the organ have been reached. A line drawn upon the skin with a soft lead pencil marks such point. Upon thus fixing a series of points, it is easy to obtain a line indicating the form of the heart. Such a form we show in Fig. 1 by a continuous line.

The subject is then made to execute a few violent movements, or, better still, is made to run for a few minutes. Then, by the same process, we obtain a line indicating the periphery of the heart and form it by a series of dots. This new outline thus obtained in our subject is shown in our figure by a dotted line. It suffices then either to photograph the subject or to make a tracing of the two lines in order to obtain a series of comparable figures.

We thus find that the form of the heart has become modified, or that the organ has displaced itself, and, in the case shown in Fig. 1, upwardly. But such changes of position may take place in various directions. The heart may likewise increase or decrease in size. In one group we may place the hearts that rise under the influence of an effort. This aspect is clearly shown in Fig. 1. In this case the organ has also somewhat increased in size. It is a question here of a nervous and slightly ethylic subject.

In Fig. 3 is traced the heart of a hysteric, who had a stomach trouble. It will be seen that the heart, after a run, has notably descended, and, at the same time, retracted.

In Figs. 4 and 5 are shown outlines of two hearts, one of which has moved outwardly toward the external part of the thorax and the other inwardly toward the median line. It is a question in the first case of a

FIG. 1.—Change in Form and Position of the Heart Under the Influence of Running. The continuous line indicates the form of the heart previous to running, and the dotted one the form after running.

woman addicted to the use of stimulants and in the other of a medical student who was somewhat nervous.

Finally, Figs. 6 and 7 show other types of modification of form that the heart may assume. In the first case the heart has increased in size, while in the second it has decreased. The first of these hearts belonged to a nervous and tuberculous young woman and the second to a woman who was exceedingly nervous.

Such variations in the form and size of the heart are not characteristic of any particular clinical type. Furthermore, if we examine certain subjects at different moments, we may find that under the same influence (an effort, for example) their hearts do not act in the same manner; sometimes increasing in size and sometimes diminishing.

To what do such modifications in the morphology of the heart correspond? They are very likely due to the fact that the organ, obliged to do work that is for the moment exaggerated, now exaggeratedly contracts and then diminishes in size, and now, powerless to react, allows itself to be distended by the blood that is sent to it by a quickened circulation, and in this case increases in size. It may likewise happen that it contracts irregularly in its various parts. We then observe the modifications in form and the movements in various directions. Upon the whole, as may be seen, the heart changes in form and size with the greatest facility.

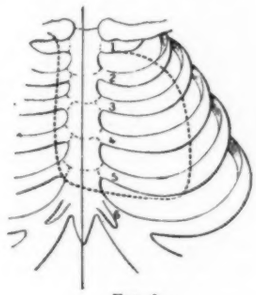


FIG. 2.

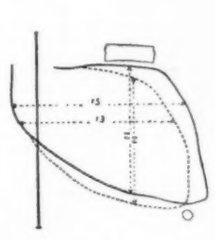


FIG. 3.

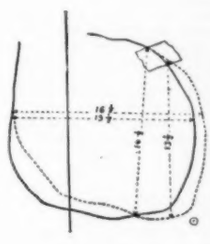


FIG. 4.

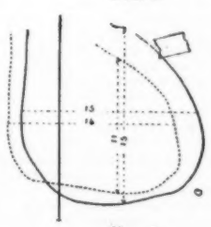


FIG. 5.

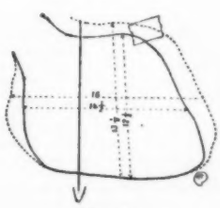


FIG. 6.

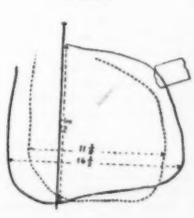


FIG. 7.

FIG. 2.—Position of the heart with respect to the thoracic cavity; the organ being outlined by means of the phonendoscope. FIG. 3.—A heart that has moved downwardly and retracted. FIG. 4.—A heart that has moved outwardly and diminished in size. FIG. 5.—A heart that has moved inwardly toward the median line. FIG. 6.—A heart that has distended with blood and thus increased in size. FIG. 7.—A heart that has contracted.

The accuracy of this very ancient notion is fully demonstrated by means of phonendoscopy.—Dr. Capitan, in La Nature.

HISTORICAL AND MYTHOLOGICAL TREES.*

STUDENTS of comparative religion have very frequently been struck with the similarity that prevails in the cosmogony in the majority of the religions of ancient times. This pertains not only to their exoteric form, but also to their esoteric meaning. We find that almost invariably the early nations, just emerging from barbarism, strongly tend toward the adoration of nature in some one of her manifold forms. This may extend toward animate or inanimate substances or objects. We frequently find, in some of the older forms of religion, that there are sacred caves, sacred mountains—fire itself is worshiped; the sun has been worshiped perhaps more extensively than any other one object; rivers have been held to be sacred—giving us all phases of worship of inanimate objects.

Again, other ancient religions, which are perhaps somewhat more refined, tend toward the worship of animate objects, and these may be either vegetable or animal. We find, in many parts of the old world—especially in India—a strong tendency toward serpent worship; and for some most mysterious reason this serpent worship prevails, even to the present time, in some parts of India. We hear of the sacred serpents being kept about the temples; and one of the great obstacles to the extermination of the venomous serpents of India is the religious dread in which the people hold them there. It seems to us, certainly, the most repulsive form of worship; but it is one of the oldest and is exceedingly difficult to exterminate. Various other animals have been held to be sacred, such as the sacred bull of Egypt, and the cats, which were mummified to an enormous extent. A vessel has arrived in England fairly loaded down with the mummies of cats found in Egypt, quite recently discovered, and now to be converted in England into fertilizing material, though formerly highly deified. Various other animals have been worshiped in Egypt; and it is not by any means rude or uncultivated nations that have resorted to this form of worship; for the Egyptians had probably the most ancient civilization. The Jews had been merely a rude, nomadic-pastoral people, and first learned the refinements of civilization during their captivity in Egypt.

There are numerous mythological legends that attach to the different smaller plants—some of them very beautiful; but I propose more particularly taking up the veneration that has been paid to different forms of trees; and among such, various historical trees and those of more or less general interest to mankind for their medicinal or hygienic virtues. Tree-worship prevailed in almost every ancient religion of which we have any knowledge. In many cases accurate knowledge has been shrouded from our view by the impenetrable veil of tradition which has surrounded these early devotions of mankind for so many thousands of years, and we have to surmise, to a certain extent; but, here and there throughout the sacred books of the world, we find most distinct indications of the veneration paid to trees—generally those beautiful in form, majestic in outline, or distinguished for longevity or some peculiar characteristic. Note the precision of detail in which the planting of the tree of life and the tree of knowledge is described in Genesis. It is quite possible (as it is now claimed by students of the Bible) that this tree of life and the tree of knowledge were not, by any means, original with the compilers of the Old Testament, but that it consisted—together with other fragments—of portions of far older books and far older traditions, which the Israelites had obtained from Mesopotamia and possibly from Egypt—more likely, however, from Mesopotomia and ancient Persia, where we find them in the sacred books of the East—very close representations; certainly the significance of those names is identical with those in the Old Testament. The tree of life and the tree of knowledge are repeatedly mentioned, though under somewhat different terms. The fruit of the tree of knowledge was plucked; that of the tree of life has never been reached. Again, there is an account of Abraham planting a grove at the well in the wilderness of Beersheba and there calling on the name of the Lord, giving us an evidence of the tree-worship prevailing at that time. There is also an account of the angels that were entertained in the plain of Mamre; and the tree under which this took place remained an object of very great worship to the descendants for a number of centuries. Eusebius tells us that it remained until the time of Constantine, when it was cut down to make way for the church erected in honor of St. George. This, of course, is not to be confounded with Abraham's oak at Hebron, which is still in existence. It seems to be held so high in esteem, and the guides take so much pride in pointing it out, that it may be almost regarded now as an object of worship.

The far East furnishes us with quite a number of good illustrations of the esteem in which trees have been held. In the mysteries of Buddhism, the successive Buddhas each had a bodhi or peepul-tree, sacred to him individually. The one at Rajayatana is the tree of Buddha Gautama, and it is related it started in growth at the time of his birth. This is one of the trees known to botanists as Ficus religiosa, very closely allied to the banyan tree (Ficus indica); and it is a peculiarity of both these Ficus trees that their branches drop shoots to the ground, where they take root, and the tree finally spreads into a large grove, sometimes over a hundred feet in diameter, and having shady walks penetrating them, so that they are used for temples, on account of the very grateful shade that they afford, also for market places.

This, in fact, explains to us why trees should be so frequently selected by early nations as objects of religious veneration. There is hardly any more beautiful object for contemplation than the magnificent picture of some of the forest trees in their appropriate season, when fairly covered with beautiful blossoms, as the dogwood tree, Judas tree, the early magnolias, especially the Chinese magnolia, which becomes covered with beautiful white blossoms as early as March. Rude man, starting out from the crudest kind of barbarism, needs the wood of the tree for a number of different purposes, and especially the wood of hard-wood trees, such as the oak and ash, for the construction of his dwellings, of his household utensils of every kind, and still more imperatively for the weapons that he makes use of in the chase and in warfare. Again, he needs it, in the northern regions, to produce fire for comfort, also to offer sacrifices to his gods; and it is therefore almost indispensable to him and seems to explain why veneration, in early nations, ran in the direction of trees.

Our Germanic and Scandinavian ancestors invariably insisted upon having their religious services in open groves. Sometimes these trees were themselves venerated as either actual deities or as the habitation of their deities; and when the early Christian missionaries arrived from Rome, sent as emissaries to destroy the faith of the Druids and that of the northern deities, they found it to be extremely difficult to eradicate from those Germanic nations the love that they had cherished for those beautiful groves. They could not make those bold warriors of the North understand why the particular god recommended by the priests of Rome should be willing to dwell only in a rough structure erected by the priests, and should decline the royal habitations of the magnificent oaks that had been the habitation of their gods. The chief difficulty of the missionaries was to separate the love of the people from these grand old trees; and it was therefore their first concern to cut down the trees, which they frequently did amid the curses and execrations of the Germanic nations. We find distinct records in England of the difficulty attending this process and of the all-pervading love of the people for their sacred oak trees, under which the Druids had celebrated their religious ceremonies for so many ages. Some of the old English chronicles relate that it was sacrilege—that it was a crime of the utmost severity—to cut down an oak tree; and occasionally we meet with allusions of oak trees having been cut down and shrieks having been heard from the falling trees which were audible for a distance of a mile or two. One of the old chronicles informs us that when St. Catharine's oak was blown down no one was willing to make use of the wood except a certain cobbler, who took the bark and tanned some hides therewith; and subsequently made thereof for himself a pair of boots. Everything went well until the first time he wore these boots; and then he was immediately stricken with leprosy in punishment for the sacrilege which he had done.

This worship of the oak was not by any means confined to the Germanic nations (among which, of course, I include the English). The Greeks, among many other trees, also worshiped the oak. Perhaps the most celebrated of all the ancient places of worship was the famous grove of oaks at Dodona, which was founded sixteen centuries before the Christian era and remained a famous oracle and a famous place of divine worship until the time of Constantine. Whenever an important question was to be decided, the oracle of Dodona was consulted; the oak trees there were the habitations of the sacred pigeons; and it was the rustling of their wings, together with the rustling of their leaves, which made certain noises that were interpreted by the priests as being a response of the oracle to the question that had been propounded. There is no evidence of any temple, or any habitation, ever having been built at Dodona; but the entire grove was the sacred place—the temple. One of the old chroniclers informs us that in the dim past two of the sacred women of the temple of Thebes were carried away by the Phenicians, and one of these subsequently founded the temple of Jupiter Ammon, in the Libyan desert, and the other one the grove of oaks at Dodona. The temple of Jupiter Ammon is of more moment to us, as it was there that the old god of the Egyptians, Ammon, was worshiped; and it is this temple of Jupiter Ammon which has given rise to the word ammonia—an article largely used in chemistry and in the household. The first form of ammoniacal salts was made by the priests of Jupiter Ammon and was called the salt of Ammon—sal ammoniac—and from this form of ammonia all the salts of ammonia were subsequently made. Paul speaks of the "unknown god," and I think it was Ammon who was meant by that.

Another plant greatly venerated was the laurel. The grove of laurel at Adelphi, in Egypt, was almost equal in renown with that of Dodona (composed of oaks) and was sacred to Apollo, who seems to have been always associated with the laurel; in fact, almost every one of the old gods and goddesses of Greece had some one individual tree or plant sacred to him or her. Thus we have the vine, sacred to Bacchus; the myrtle, to Venus Aphrodite; the laurel, to Apollo; the oak was sacred to Jupiter among the Romans, to Zeus among the Greeks, and to Thor among our own ancestors—which name (Thor) we use every time we speak of Thursday. The laurel was used not only as a memorial of Apollo, but it was also regarded as being absolutely necessary, for every triumph, to make a crown of laurels to give to the conqueror in the Roman and Egyptian games and after their wars. Laurel leaves are chiefly used now by the French and also by some of the German cooks in giving a flavor to roast beef. At the present time the laurel trees are quite largely imported from Europe and occasionally are grown as a mammoth shrub—not to be confounded, however, with the sheep laurel nor the mountain laurel.

Next in importance to the oak, perhaps, is the ash tree. The old tradition of our immediate forefathers contemplated a magnificent mundane tree, a sacred ash, known as Yggdrasil, regarded as the most magnificent and grandest tree in the entire world—in fact, covered the entire world. It had three great roots, under one of which was the fountain of wisdom; under another was situated the Erdar fountain, where the gods met in daily council; and under the third root the men themselves were situated. Another legend—that of the older Edda—states that the daily emanations, the dew, dropping down from the leaves of this grand ash, gave rise to every living thing on earth, animals as well as vegetables, so that men themselves, according to this northern legend, have sprung from this sacred Yggdrasil, or sacred ash tree of the Norse mythology. Still another legend says that, on one occasion, the gods Odin, Haenir and Lodur were walking along the seashore and saw two sticks of wood drifting on the ocean, without aim, object or destiny. They picked these up, and Odin breathed into them the breath of life. Lodur gave them their senses, and the third of the trinity gave them their body-form. One was made into a man and they called him Askr, or ash-man; and the other into a woman, whom they called Embla; and this is their account of the creation of man.

The ash tree is found in Europe, farther north than almost any other hard-wood tree, so that it became an object of very great importance to these northern nations. In still many other parts of the world we find that this adoration of nature takes the form of adoring the seasons. In the extreme north, where the winter is so very long, so intensely cold and disagreeable, and the short spring ushers in the summer—the season of plenty, warmth and beauty (the absence of food, beauty, warmth and comfort marking the winter)—there the idea of the spring was first typified and personified in the form of Baldur, the white or fair-haired god. He was called the joyous god, whom everybody loved and who had, in turn, to get away from the darker powers, to be killed annually and forced to retire into the interior of the earth and be succeeded for a period by the evil spirit which brought desolation, misery, want, starvation and everything uncomfortable.

In Egypt the same story finds expression in the idea of Isis and Osiris. The fertility of Egypt is dependent on the annual overflow of the Nile, which occurs pretty regularly and leaves an abundant deposit of alluvium, making Egypt the most fertile country, perhaps, in the world. When the flood recedes and the plenitude of water disappears, Osiris, the beneficent deity, is said to be stolen by Typhon, the evil spirit there, who is fabled to have dismembered Osiris' body and scattered it to the winds; and Isis, the beloved wife, wanders through the country in search of Osiris' remains. Finally she recovers them, and this happens about the next overflow of the Nile; the people cry out and rejoice; Osiris is found.

In Greece we have practically the same story, where the daughter of Ceres is carried away by the spirit of the lower regions and the winter comes on—the period of desolation. In the springtime she is again permitted to return to her mother, Ceres; and the event is celebrated in the most extravagant manner by the famous Eleusinian mysteries, where the entire nation is joyous, only, in this case, she is allowed to stay for nine months, it being a warmer climate, while, in the far North, the god of the sun is allowed to stay only six months or less.

The ancient Persians had a peculiarly sacred tree, or sacred shrub, the Soma or Homa shrub, which their old chroniclers tell us was the first of all the plants that were planted by their supreme spirit (the Houra Masdu), and is related to have most fabulous properties. He who eats of its fruit attains to eternal life, complete knowledge, perfect wisdom. It is the most powerfully reinvigorating substance on earth; and it is practically possessed of all the good attributes conceivable; so that it is quite possible that this homa, or soma, shrub may be the prototype of the tree of knowledge mentioned in other religions. The same soma is also quoted by the Brahmans and by the Buddhists; and it is probably that to which Sir Edwin Arnold alludes in the "Light of Asia," when he gives it as one of the counsels of Buddha:

"Shun drugs and drink which work the head annoy.
Keen minds, clear bodies, need no soma juice."

This same plant is believed to have been the Asclepias acida, and from its juice an alcoholic beverage was fermented which had stimulating properties; so that probably Buddha is entirely correct in advising man to abstain therefrom.

While the Mohammedans abstain religiously from alcohol and wine, they find it extremely difficult to get along without some other stimulant, and therefore have taken to two chief stimulants, which are probably, if anything, more injurious than the alcohol itself, namely, the opium, which they smoke largely, and then the smoking of hashish (Indian hemp), which is so very largely indulged in by them and sometimes produces such extremely disagreeable consequences.

In the Bible a number of other substances are mentioned which seem to have been reserved for the use of the priests, among them frankincense, the olibanum of the druggists, which was one of the ingredients of which Moses was commanded to make the holy oil and the ointment for anointing. This frankincense is obtained from the far East and is a drug made from the dry secretion of the Boswellia thurifera and is consumed to an enormous extent in the observances of the Romish church. The peculiar odor continuously pervading their churches is due to the smoke of frankincense, which odor is given forth whenever it is ignited. This has been used not only by the Roman Catholics, but also by some of the Eastern religions, notably in some of the Brahmanical ceremonies.

The same material from which amber jewelry is made is also used. The story connected with the amber is to the effect that after Phaeton had been killed for want of skill in his attempt to drive the chariot of the sun, his sisters, the Heliades, the daughters of the sun, wept for a long time; so long, in fact, that finally, out of pity for them, they were changed into larch trees, which grew alongside of a river; and the tears which continued to fall from them dropped beneath the water and they were then changed into what the Greeks call elektron, or amber. One of the wise men of Greece, Thales of Miletus, first elicited the electric spark by rubbing a piece of amber with a piece of fur; and he believed the electric spark to be a property inherent in amber only; and it is hence we obtain the modern word "electricity," from the old Greek word for amber, supposed to have been the tears of the Heliades or daughters of the sun. At the present time amber is obtained from underneath the waters of the Baltic. It is a resin which was produced by coniferous trees that lived in prehistoric times—perhaps a hundred thousand years ago; and they had a resin very much like our ordinary resin which dropped beneath the sea, and therefore its peculiar properties. Small fragments have been found in New Jersey.

Myrrh is obtained from the shores of the Mediterranean (North Africa) and also the shores of Arabia. It seems to have been regarded as a valuable perfume. With our large assortment of modern perfumery there are few who would choose myrrh, nevertheless, it is still used in tooth washes and tooth powders, and also has some medicinal properties. It is derived from the Commiphora balsamina; and there is a Greek legend

* A lecture delivered at the summer meeting of the Bucks County Natural Science Association at Buckingham, Pa., by Dr. Adolph W. Miller, lecturer on Materia Medica at the University of Pennsylvania.

connected with this, to the effect that the nymph Myrrha at one time incurred the jealousy of heaven-born Venus, who, in order to get rid of her, converted her into a myrtle tree; and the poor nymph Myrrha, the daughter of King Cynerus, has ever since then been weeping tears for her sad fate; and it is these tears that are now being used by the druggists under the name of myrrh.

Benzoin is another odorous gum used largely in the celebrations of the Greek Catholic church. It does not appear to have been known to the ancients, but appears first during the middle ages, and then, at one time, it commanded almost fabulous prices. It contains a peculiar principle known as benzoic acid, which may be obtained from it by heating it, and is a constituent of the fumigating pastilles which are used for perfuming apartments or removing disagreeable odors. The name benzoin is said to be a contraction of the Arabic words lubon jawee—the milk of the jawee (being the Arabic name for Sumatra, one of the neighboring countries). From these two Arabic words, lubon jawee, both the name olibanum and the name benzoin were coined, by simply contracting them and mutilating them.

Among the Hindoos—both Brahmans and Buddhists—perhaps the most sacred wood, for which they have the highest regard, is the holy sandal wood. It is frequently worked up into jewel cases, fans and other objects of more or less interest. The Chinese are extremely expert in carving sandal wood. This tree numbers several species, the most valuable being the Santalum album; and it was formerly indigenous to India, China and various Pacific islands; but it has been utilized to such an enormous extent in the religious observances of the East that in many of the Eastern countries where it was formerly abundant it has now become extinct. We have a representative of this order (the Santalaceæ) with us—the little Pterocarpus santalinus, which grows in this neighborhood. The sandal wood tree is one of important size, growing 20 to 25 feet high; and is composed, like most other trees, of a hard wood and a sappy wood. It is the hard wood only which contains the peculiar odor and fragrance of the sandal. It is also of great value to the cabinet-makers of the East, being about the only tree not attacked by the destructive white ants. They will eat everything else in the shape of furniture—literally tear it to pieces; but they seem to have no appetite—do not relish—the strong odor of the sandal wood. In India, when a man dies, and his friends want to show their respect, the custom of the country demands that they purchase little sticks of sandal wood to send to the bereaved family, in order that his funeral pyre may be constructed of sandal wood, and that he may thus be burned in odorous smoke in the same way that Sardanapalus was burned up when he found he was about to be conquered. Many of the perfumes of today have a basis of sandal wood—such as marechal.

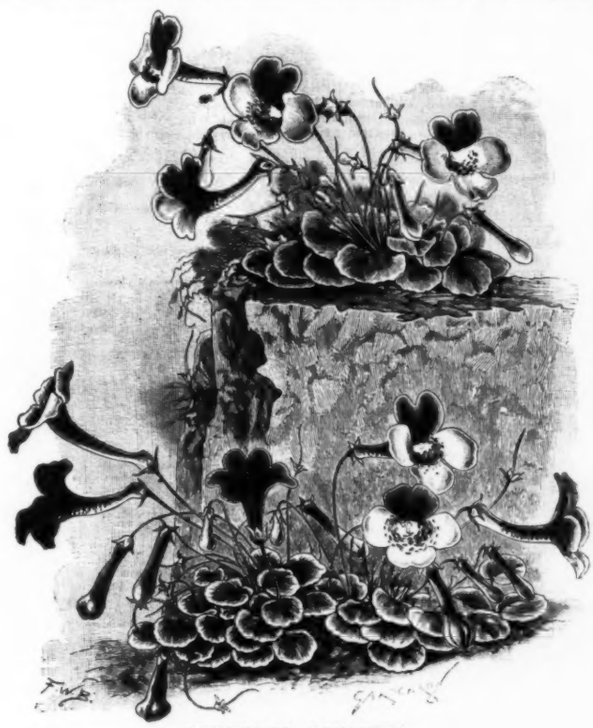
The cone of the cedar of Lebanon (frequently mentioned as being the material of which the temple of Solomon was constructed) has a different appearance from the cone of all cone-bearing trees with which we are familiar. There are cedars of Lebanon growing in Druid Hill Park, in Baltimore, Md.

Passing from the far East to our own hemisphere, we have some sacred trees in South America. When the Spanish invaders landed on the coast of Peru, they found the Incas and their followers in a high state of civilization, having a peculiar religion of their own, having deities which, to a certain extent, resembled those of other countries, and among whom was a female deity with some of the attributes of the Grecian Venus; and wherever a figure of this Peruvian Venus was represented she was always depicted with a peculiar leaf in her hand. The native Peruvians were in the habit of chewing the leaf of a shrub; and they esteemed it a special privilege to chew this leaf, claiming for it the most marvelous properties. A young man was not allowed to chew it until he had performed some deed of valor, nor until he had arrived at a certain age. They sometimes surreptitiously obtained these leaves, but were punished when discovered in the act of imposition. The Spanish found in the use of this leaf an obstacle to the christianization of the Peruvians; and they therefore forbade the cultivation of the plant and the use of the leaf, but found, after a time, that without the use of the leaf the miserable peons (the slaves into which the Spaniards had converted them) were physically unable to perform the severe tasks demanded of them; and they, therefore, as a matter of expediency, permitted them to cultivate and chew the beloved leaf. This was known to the Peruvians as coca. When the plant was taken to the celebrated Swedish botanist, Linnaeus, he named it Erythroxylon coca. At the present time we enumerate this sacred plant as among the Linaceæ. From almost immemorial time this plant has been cultivated (I believe there are none of the plants found native); and it is stated as a fact that at the present time, in Peru and Bolivia, 40,000,000 pounds of these coca leaves are gathered annually. Each individual leaf is carefully picked by hand, carefully dried and packed in bags and sent to Europe. When examined by European chemists, the coca leaf was found to contain a peculiar alkaloid of very singular properties, producing local anæsthesia. It was first used for operations on the eye, and found to be extremely beneficent; as almost any operation could be performed thereon without seriously affecting the patient.

A great deal of injury is done by the excessive use of coca leaves and cocaine. The chewing of the leaves with an alkaline substance produces a feeling in the body benumbing the actual craving for food and drink. It is not food itself, but by chewing coca leaves one can get along without suffering thirst and hunger for nearly a week. These Peruvian Indians, having a copious supply of coca leaves and a little bag of the ashes of a small plant which they burn (and the ashes are said to be peculiarly valuable to be chewed in connection with the coca), will start out for a journey over the Andes, where the traveling is exceedingly arduous; and they will be able to travel on scarcely any food for at least a week; but, returned, when they sit down to the table, they eat enough to make up for their week's abstinence and thereby do themselves a good deal of injury. While possibly the use of coca does not abbreviate life, those who are habitually chewing it have a peculiarly sallow complexion and very offensive breath; eyes are sunken, and they seem to be in an extremely unhygienic condition. A number of patent medicines are in use at the present time involving this property—one being now especially popular and widely advertised—which make us feel good for a little time; but after that influence passes off, we feel worse than before.

A story has gone the rounds that physicians have found a way of entirely obtunding the desire for alcoholic beverages vastly superior to the gold cure treatment, consisting in the use of small doses of morphine—that whenever the morphine habit was established, the alcoholic habit was entirely eradicated—the only trouble being that it was somewhat difficult to get rid of the morphine habit, and that was obliterated by establishing the cocaine habit. The cure was entirely successful, perfectly satisfactory, except for one thing—that they had not as yet discovered anything for getting rid of the cocaine habit. It is simply going from bad to worse; the morphine is worse than alcohol, and cocaine is far worse than morphine. I have sometimes seen patients under the influence of cocaine, and they were as near insanity as could be. The coca leaves have a taste as of dried tea.

Cinnamon and cassia are both mentioned in Holy Writ as ingredients in the sacred oil reserved for the use of the priests in the temple; and the injunction is also delivered that "He who shall sacrilegiously make use of this holy ointment shall be cut off from his people." In ordinary language cinnamon and cassia are identical; but that is very far from being correct. Ordinary cassia (generally called cinnamon) is found in all of the grocery stores and drug stores. The fine, delicate spice—the true cinnamon—is the kinnamomon of the Greeks. Singular as it may seem, the word has undergone hardly any change whatever. The true Ceylon cinnamon has from time immemorial been furnished by the island of Ceylon, and not by any other part of the world; and it is the possession of this valuable spice which has made the island of Ceylon to be sought for, fought for and made the object of contention among different nations for thousands of years.



SINNINGIA CONCINNA.

The earliest tradition in connection with the island of Ceylon, famous for its cinnamon, is that Rama, one of the avatars, got possession of it some 8,000 years ago in this way: His wife had been stolen from him by the King of Ceylon, and he invoked the aid of the god of the monkeys, and with this aid immense pieces of rock were jerked from the Himalaya Mountains and were dashed from the mainland of India toward Ceylon. It is said to be a fact that at one point the distance from the mainland to that island is only a few miles, and that this is partly bridged over by immense rocks there; further, that when Rama succeeded in crossing over to Ceylon with the aid of the monkey allies, he regained possession of his wife and was happy ever after; but in more historic times Ceylon became famous on account of the peculiar mountain known to Western nations as Adam's Peak; and it is on the elevations of this mountain there occurs a depression said to bear some resemblance to the human foot. The Buddhists claim that Buddha set his foot there; the Christians claim the act for Adam and named the mountain from it, Adam's Peak; and various churches have had possession of it. The island was conquered by the Portuguese, then by the Dutch, and finally by the English, who now hold it. The extremely high price which cinnamon commanded in the middle ages was the chief incentive for the circumnavigation of Africa, which was accomplished in 1505 by the Portuguese, and shortly afterward they got possession of the island of Ceylon. Previous to that time it was necessary to bring this spice first to India, then across the Indian Ocean, with its monsoons, and then to the Red Sea, and finally across the Isthmus of Suez; and every one that handled it (including the sultans of Egypt) exacted a very heavy tribute for every handling, so that during the middle ages it was more precious than silver and gold; it commanded almost fabulous sums—the present of a pound or so of cinnamon was regarded as fit to be given an emperor. The real Ceylon cinnamon is often made up of a succession of exceedingly thin rolls of bark placed one within another, telescope fashion, and thus imported in the shape of long canes. It is claimed by many that the custom of putting up Christmas trees, and dancing around them and celebrating the Christmas time, is a direct sequel of the tree worship of our ancestors—that it came down to us from Druidic times and has been kept up ever since; and it is also claimed that the maypole dance of England is another proof of the fact of these ancient customs surviving after their true meaning has been lost.

Immense veneration was paid to the cross during the middle ages, the fable then current running thus: When Adam died, and before he was buried, an angel was said to have placed in his mouth three seeds, from which three large trees sprouted—the cypress, pine and cedar. In the course of time these three trees amalgamated—united—and became famous throughout the world for their marvelous curing properties. They were visited by the Queen of Sheba, who caused this wonderful tree to be buried beneath the Pool of Bethesda, which owed its healing properties to this Adam's tree. At the time of the crucifixion (so runs the legend) the tree arose from the Pool of Bethesda of its own accord and offered its services for the cross, and was thus used; and the cross itself was constructed from the wood of these three trees, and it was subsequently buried in Calvary. When the Empress Helena, of Constantinople, visited Jerusalem, she discovered the true cross by its marvelous healing properties, and she then caused a portion of it to be brought to the mosque of St. Sophia. During all the middle ages there was nothing in the world at all comparable in value to a portion of the true cross. All the cathedrals and churches claimed to possess portions of the true cross, magnificently enshrined in glass, silver and precious stones; they seemed to be beyond all earthly possession. There was enough material for a very much greater cross than had ever existed, and finally the Church of Rome issued a proclamation to the effect that the true cross was endowed with the property of self-reproduction, and thus accounted for the abundance of portions of the cross. In the thirteenth century, Philippe Auguste, of France, erected L'Chapelle des Sainte, said to be the most magnificent shrine surrounding what is alleged to be a portion of the holy cross.

SINNINGIA CONCINNA (STENOGASTRA CONCINNA.)

THE accompanying illustration from the pencil of Mr. F. W. Burbidge, M.A., V.M.H., represents one of the most charming of Gesnerads. It is an immediate relative of the garden gloxinia, but contrasts strongly with it in being many times smaller, and also in its much quieter coloration. In this it does not vary, being always white from the three lower segments down the tube, and purple from the two upper segments, the throat covered with small spots, and the white segments edged with violet. The flowers are very numerous, and thus make a very attractive display, though only about seven-eighths of an inch long. The leaves are round, slightly heart shaped, and of dark green color, with purplish veins, reminding one of Nægelia zebrina in miniature: they are borne on very slender stems, which proceed from a tiny tuber. Flowers are produced over a long season, but are most numerous and effective in spring. It is a native of Brazil. Though very charming in any stove, it is scarcely now a commercial plant, but finds refuge at Kew and Cambridge, the accompanying illustration having been prepared in the latter garden. Its culture is not difficult, but requires some care. If treated much as a gloxinia, it is perfectly happy, but several should be grown in a pan. It is increased by separating and striking the shoots.

We are indebted to The Gardeners' Chronicle for the cut and copy.

TRADE AND INDUSTRIES IN THE PHILIPPINE ISLANDS.

UNDER Spanish rule, only the seaports of Manila, Iloilo, Cebu and Zamboanga were open to foreign trade. At all other places, Spaniards and natives alone were allowed to do business. Among foreigners, Chinese are the most numerous, exceeding even the Spanish contingent of the population. Europeans of other nationalities than Spanish number only about 300 throughout the Philippine Islands.

The unit of the currency is the silver dollar (peso). The unit of weight is the pickul, equal to about 143 pounds. The units of measure of length are the meter, the yard, also a local unit equal to about 2 feet 9 inches.

The banking business is chiefly in the hands of the "Banco Español Filipino," the "Hongkong and Shanghai Banking Corporation," and the "Chartered Bank of India, Australia, and China." The customary rate of interest (at the banks) is 7 per cent.

Railways are very little developed. On Luzon there is only one railway line, about 125 miles long, from Manila to Dagupon. This line was completed in 1892 by a British company and cost 11,000,000 pesos. A steam tramway connects Manila with the suburb of Malabon. The island of Mindanao possesses a narrow gage military railway of about 21 miles; this railway was constructed by Germans. Among the lines projected, the most important ones are that from Manila to Batangas (about 80 miles), and an electric railway from Iloilo to Jaro (about 2½ miles).

The shipping is done by the various companies running steamers to Hongkong. The Spanish mail steamers of the Compañia Transatlantica have (or had) monthly sailings from Liverpool to Spanish ports, Singapore, and Manila.

The mineral resources are chiefly gold, copper, iron, lead, and coal. Gold is washed by the natives in many places, also by a few small English companies in the province of Camarines, but the quantity obtained is small. Copper is found on Luzon at Lupac, Agbas, and Suyne, iron at Suyne, and lead at Paracali and Mambulao. Coal is found principally on Cebu, the output of two collieries at Compostella and Danao being about 5,000 tons a month.

The industrial establishments at Manila are numerous and important. There are very large cigar and cigarette factories, some of them employing up to 4,000 people. Manila further possesses sugar refineries, steam mills, four rope factories, one brewery, a large saw mill, a cement plate factory, and others. Spanish companies have charge of the telephones and of the electric lighting of the streets and public and private buildings.

Foreign business interests are centered in Manila, where Spanish firms have 45 establishments; Chinese firms, 40; German, 19; British, 17; Swiss, 6; French, 2; Dutch, 1; and Belgian, 1. The general importing trade is mostly in the hands of the Germans and Swiss; the British have the largest share of the most important exports, viz., sugar and hemp, and the import trade in woven goods. Most of the shipping is done by British firms.

Among the articles for which there is a good market in the Philippines are needles and pins, sewing machines, simple tools, knives, spoons, enameled dishes, pans, etc. In Iloilo and Cebu, where the large sugar plantations are situated, there is a demand for narrow-gage railways. Coal is imported mainly from Japan and Australia, as the domestic production is not sufficient to meet the demand. Sixty-one thousand tons were imported in 1895.

The chief export articles are hemp, sugar, tobacco, copra, coffee, indigo, logwood, hides, and hats. We are indebted to Stahl und Eisen for the particulars.

ANIMATED PICTURES.

AN interesting article in The Popular Science Monthly (December, 1897) describes some of the more recent forms of apparatus for the projection of animated pictures, and also adds suggestions for some applications which offer interesting possibilities. Instead of taking the original photographs from ordinary objects in rapid motion, it is possible to make them at much longer intervals, such as hours, days or weeks, so as to obtain successive views of objects of which the changes occur but slowly, such, for example, as the growth of a plant, or even of a human being. These images could then be exhibited at such a rate of speed as to appear quite continuous, thus exhibiting to the eye the growth of a plant or the blossoming of a flower in as short a space of time as is claimed by any Hindoo fakir, and with far more truth.

"Such views could not fail to produce an effect at once marvelous, unique, and instructive. As pictures upon the canvas, the plants would grow and develop before the eyes of the onlookers, throwing out leaf upon leaf and visibly increasing their dimensions. Here and there a flower or flower-cluster might make its appearance, the individual blossoms bursting forth suddenly, and remaining visible for a brief period only. As object-lessons in botany such motion-pictures would be invaluable, while the general public, not less than the advanced student of science, would regard them with feelings of keenest interest."

But there is another possible application of scientific value and interest. Many phenomena which it is most important to investigate carefully occur too rapidly for the eye to perceive with accuracy, and the study of such subjects is beset with difficulties. Photographed upon a rapidly-moving film, however, the occurrence may be repeated again and again, until all its details have been observed, and, as the rate of speed of the projecting film may be reduced, the critical point of the phenomenon may be caught and identified.

For example, a piece of metal may be placed in a testing machine and a continually increasing stress applied until the elastic limit has been passed and the point of rupture reached. During this entire time a continuous film might be filled with photographs, constituting a complete visual record of the test, which could then be examined at leisure at as much slower speed as desired, any number of times, and, by comparison with the graphical record of stresses and strains, add materially to our knowledge of the subject.

These are but isolated examples of the possibilities of the cinematograph as an instrument of scientific research, and other applications will readily appear.

Recent Books.

Glass Blowing and Working for Amateurs. Experimentalists and Technicians. Based upon a course of Lecture Demonstrations given under the Auspices of the Technical Education Committee of the Middlesex County Council. With colored frontispiece and numerous illustrations. By Thomas Bolas. 12mo, cloth. 212 pages. London, 1898 ..... $1 00

Greenhouse Management. A Manual for Florists and Flower Lovers on the Forcing of Flowers, Vegetables and Fruits in Greenhouses, and the Propagation and Care of House Plants. By L. R. Taft. Illustrated. 12mo, cloth. 382 pages. New York, 1898. $1 50

House Decoration. Comprising Whitewashing, Paperhanging, Painting, etc. With numerous engravings and diagrams. Edited by Paul N. Hasluck. (Work Handbooks.) 16mo, cloth, 160 pages, illustrated. London, 1897 ..... $0 50

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Hydraulic Machinery. With an Introduction to Hydraulics. By Robert Gordon Blaine. 8vo, cloth. 383 pages. Illustrated. London, 1897 ..... $5 00

Ice Making. Practical Ice Making and Refrigerating. A Plain, Common Sense Series of Papers on the Construction and Operation of Ice Making and Refrigerating Plants and Machinery. By Eugene T. Skinkle, "The Boy." 12mo, cloth. 220 pages. Illustrated. Chicago, 1897 ..... $1 50

Light. Visible and Invisible. A series of Lectures delivered at the Royal Institution of Great Britain, at Christmas, 1896. By Silvanus P. Thompson. 12mo, cloth. 294 pages. 158 illustrations. London and New York, 1897 ..... $1 50

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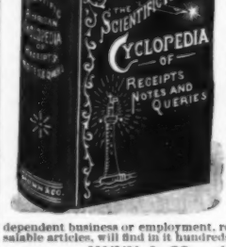

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